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THE CAREER OF A TECHNICAL PAPER.

The relentless march of time necessarily brings with it anniversaries which serve as milestones in the history of institutions, as well as of men and nations, and it is a natural and appropriate thing that note should be taken of such occasions. These anniversary seasons and periods are not only enjoyable but useful, and even when sad may carry with them some lesson or stimulus. It sometimes happens that these memorial occasions are of interest chiefly to the person most directly concerned, but in the case of a journal, for example, whose sphere of activity and influence may be co-extensive with the boundaries of the art it represents, and even overpass them, it is believed that an anniversary such as that which is celebrated by ELECTRICAL WORLD AND ENGINEER this week is one of which other people would like to be reminded. In fact, the number of friends who have contributed reminiscences and words of congratulation to the present issue may be taken as an indication that the event is regarded as one constituting part of the history of electricity and its development in the United States; and proving that whatever good work the journal has done or has attempted to do in its thirty years of existence has not gone unrecognized by a generous and sympathetic public.

The record of this journal in its humble beginnings; its changes of name and habitat, its absorptions, amalgamations and consolidations; its notable growth and other aspects, is a fitting epitome or summary of the electrical art as a whole which it has sought to

mirror and to foster. This journal began its career in 1874 as the *Operator*, founded as an organ of a very modest character for telegraphers, but it was no sooner started than it saw new opportunities in the coming developments of electricity, so that in 1876 the telephone was hardly invented before the *Operator* began to discuss it. In the same way it noted also the beginnings of electric lighting, and in the year 1882 published a series of articles on the subject which were recognized as doing a great deal to educate engineers and the public in the principles and adoption of the new illuminant. The year 1882 saw also the first issue of *The Electrician*, which seventeen years later, in another guise, was destined to be consolidated with the *Operator*, also under another name.

In January, 1883, the little telegraph journal became *The Operator and Electrical World*, but its growth throughout the earlier part of that year was so rapid it was realized that it would be better to make a further change, and on April 28 the current was subdivided and *The Electrical World* began its separate career. The next year, 1884, witnessed the electrical exhibition in Philadelphia and the electrical congress there, both events giving a great stimulus to the art, and the same year saw also the foundation of the American Institute of Electrical Engineers, the organizing circular for which was issued by the editors, and from the offices, of *The Electrical World*. At that exhibition also a great stimulus was given to the use of electricity in printing, by the use of an electric motor there, with which some 70,000 copies of the paper were printed. In 1888 *The Electrician* became *The Electrical Engineer*, but remained a monthly until 1890, which witnessed its first weekly issue. In 1894 *The Electrical World*, which had been published in the familiar old folio style, still favored by some weekly journals, adopted its present quarto style, which has been found much more convenient by readers and which had always characterized *The Electrician*. A period of absorption and consolidation now set in, the *Electric Railway Gazette* being absorbed in 1896, while in 1899 the consolidation took place of *The Electrical World* and *The Electrical Engineer*, the change of ownership and management being accompanied by the adoption of the title Electrical World and Engineer, under which for the past five years the journal has been conducted.

This in brief, and not touching on many points of interest, is the record of the journal as a publication and business. A word or two may be added with regard to the personnel of the institution, omitting those at present connected with it. On the business side and also in regard to a great deal of the editorial work, the papers which have gone to make up the present journal enjoyed the energy, activity and sound business acumen of such men as Messrs. W. J. Johnston, G. M. Phelps, C. E. Stump and F. R. Colvin. The editorial staff, impressing upon the various journals the stamp of high ability, sound judgment, strict impartialty and the conscientious discharge of journalistic duty, has included such men as F. L. Pope, C. O. Mailloux, Louis Bell, C. J. H. Woodbury, Joseph Wetzler, J. E. Woodbridge, R. W. Pope, N. S. Keith, H. W. Frye, G. H. Stockbridge, C. T. Rittenhouse and C. T. Child. Several of these men, some of whom have passed away, distinguished themselves not only by editorial skill, but by accomplishment in other fields of electrical endeavor, and their work constitutes in large measure whatever of strength and importance this publication may now possess as the recognized leader in electrical journalism.

Thirty years is perhaps a long time in the life of a journal, especially in the technical field, but is not a particularly long period in any art. Electricity, however, is unquestionably quite young as compared with other branches of science and industry, and as one looks back over the past thirty years it is hard to believe that any period of equal duration could be more closely crowded with glorious life and achievement than has been the era 1874-1904. But should coming years hold in them potentialities and accomplishments in electricity greater than any that have been known in the past, it is hoped and believed that the Electrical World and Engineer and those who conduct it will be found adequate and faithful to every demand that may be made upon them in the production of a fearless, progressive, authoritative and independent journal.

Side Lights of History.

In preparing to issue an anniversary number celebrating the close of its thirty years of continuous existence and beginning its fourth decade, the Electrical World and Engineer believed that while it was unnecessary and superfluous to recapitulate seriously the whole marvelous record of the period between 1874 and 1904, it might do something that would be of lasting value and interest by giving space to the ideas and reminiscences of some of the men who had been leaders as thinkers and workers during the time named. The events connected with the evolution and development of modern telegraphy, the telephone, the arc light, the incandescent lamp, the electric motor, the electric railway, electric lighting, electric heating and other branches, are pretty familiar to-day and may be found in the books. But there is still unwritten a great deal of personal history and reminiscence which must in days to come constitute for the historian and the student much of the material that will be most valuable in re-creating the actual atmosphere and events surrounding those great inventions at the time of their birth and during their struggles for foothold and supremacy.

The editors of this journal deem themselves fortunate to have been able to bring together within the pages of this present issue so large a volume of personal recollections and data belonging in the class which the French call happily *memoirs pour servir*, and having that charm and fascination which must always attach to autobiography. It will be seen that these articles cover all the great inventions of the period and that many of them present facts under new illumination. It might indeed be urged that a single issue embracing the contributions of such well-known captains as Edison, Tesla, Sprague, Coffin, Griffin, Kennelly, Bell, Anthony—to name but a few—has by that very reason a unique permanent value. Such articles are, indeed, side lights of history, but they are something more, especially when thus brought together in celebration of a specific anniversary in the art which has seen such wonderful and unparalleled expansion during the past thirty years. The Electrical World and Engineer is proud to present the contributions of these friends, whose presence in its pages at such a time it regards as a mark of good will and esteem; and it takes this opportunity of acknowledging its deep appreciation, as well as of expressing its sense that it is thus pledged to even greater effort in the future.

The Portrait Supplement.

In connection with its present anniversary issue, the Electrical World and Engineer has thought that it might be interesting to give in one group the portraits of some typical leaders in the thirty years of American electrical development included in its own lifetime, namely, 1874 to 1904. This period misses narrowly the creators of the telegraphic era in America, but includes the pioneers in every other branch, as well as one or two men who may be regarded as bridging the gap between the old world and the new of electrical development. It is thought, therefore, that the Supplement to this issue will be found of more than general interest, and that while it is likely to be preserved for its intrinsic value, it will also serve

to suggest a few timely thoughts as to the scope and variety of the modern science and its applications. Electricity has laid hands upon so many departments of life and has affected so many branches of industry, finance and commerce, it is no longer possible to find its leaders or its heroes in one separate class or group of men. The field has already become so wide and so large, it is only possible in such a supplement as is here presented to include leaders who are typical and alongside whom might be placed others with propriety, pre-eminent in their own group or class, were it not for the claims which other categories have for consideration and inclusion.

In the field of pure science one would certainly select and name first of all Prof. Rowland, honored abroad even more than in his own country, yet even he did not disdain to work on the utilitarian side of electricity and to take out patents. With him might well be classed Dr. Pupin as representing the present physical and educational sides of electricity, himself also an inventor and patentee of no mean order. As between the old school of telegraphy and the modern school of electrical engineering there would seem to be little in common, for Edison is the only connecting link between Gray and Farmer, of the earlier period, unless we take into account F. L. Pope, who doubtless had higher claims as the typical electrical journalist of the last century. Farmer again belongs not only to the telegraphic stratum or branch, but is connected with the new dynamo days through Weston, who also exemplifies the evolution of the modern electric lighting and power art out of the prior electroplating practice. It is true, of course, that in a broad sense the telephonic group of inventors ought to be considered as lineal descendants of the telegraphers, but there is no question that such men as Bell and Blake have dealt with an altogether different set of problems from those which confronted Morse and House; and that in the telephonic engineering done by Carty and his colleagues there is no parallel whatsoever to be found in any other branch of electrical engineering.

It is the electric lighting period which introduces us to a great group of notable men and brings to the front the large manufacturers typified by such brilliant examples as Coffin and Westinghouse, the first of whom, however, has devoted his energies entirely to the financial development and industrial exploitation of the art, while Westinghouse has further claims to consideration as a designer and inventor. Here again he links with Wheeler as a manufacturer, engineer and inventor, while Wheeler has the further distinction of laying the foundations broadly and liberally of the Institute Library and of thus setting in motion the forces which have of late brought electrical engineering in closer touch with the older professions than ever before. In the electric lighting field, Edison at once comes to the front again as he does in those of telegraphy and telephony; while shoulder to shoulder with him stand such masters as Brush, Thomson and Wood, the work of each man being that of a successful pioneer. Edison again forms a starting point in regard to the electric railway art, going back also to Farmer and embracing men whose names will be even more widely known in the future than that are to-day, such as Sprague and Van Depoele. In the manipulation, transmission and distribution of current beginning with this modern period of electric light and power, are associated again most intimately several who have already been mentioned and others in the group, such as Stanley, Steinmetz, Scott and Shallenberger, the last of whom indeed might well be considered along with Weston, Thomson and Edison in the invention and perfection of measuring instruments. Quite in a class by himself from his advanced and daring work and predictions as to the future, is Tesla, although he ranks high already chiefly through his successful efforts to render alternating current available for power and transmission purposes. Going back to the earliest days of electrical development on the chemical line of advance, one must include such men as Farmer, Edison and Weston, but these would not be chosen as typical of the latest period; and it is for this reason that in this group places of honor are given to such men as Hall, Cowles, Acheson and Bradley, although the last two named have further claims to consideration; one as a pioneer in the electric lighting field, and the other as a most fertile and progressive inventor of dynamo electric apparatus.

But even when all this has been said, and a fair ascription of credit has been made to these men and the colleagues or branches whom they represent, a great deal of work is left untouched of equal value and importance in rounding out the availability of electricity to the public. It is for this reason that portraits are presented of such men as Leonard, inventor and engineer in many fields, and particularly prominent in that of resistances and electric heating. Other vital lines of work are typified by Pearson as a designer of central power plants; Insull, not only a manufacturer but a typical central station manager supplying current in enormous volume for every public necessity; or Kellogg, also an inventor, but conspicuous chiefly as a manufacturer and as a typical figure in the wonderful independent telephone movement which has been one of the leading electrical features of the present century, and has affected very other branch of electrical industry. Last but not least, comes Fish, typical in every way of the prominent part played by the legal fraternity in electrical development from its very beginning, and himself one who has contested more causes of tremendous importance in the electrical field than any other man living or dead, while again necessitating consideration as the business head of the greatest telephonic system in the world.

It is easy to imagine the substitution of other men for some of those whose portraits are presented in this Supplement, especially if undue weight is given to the claims of some particular field or branch of electrical industry over the others. The attempt has been made, however, to select men who, individually and collectively, may be taken to stand for the sciences and arts to which they have devoted their lives and whom their associates agree in honoring as typical leaders in the past thirty years of American electrical development.

A CAMPAIGN OF PUBLICITY.

It always seemed to us, as well as to a great many other people, that the advertising pages of any paper are one of its most interesting and instructive features; and this idea is particularly true with regard to technical and trade papers from the fact that so much apparatus is therein illustrated and described. The manufacturer in his own space in the advertising columns is practically at liberty to show what he likes and say what he likes with regard to his apparatus, and very often he first puts on view there with all its claims the device or appliance for which superiority over everything else in the same field is asserted. It thus happens that the advertising pages of such a journal as the ELECTRICAL WORLD AND ENGINEER throughout a term of thirty years and such a period as that which it celebrates in this issue, present an invaluable picture of the industrial development of the time, one that could not possibly be overlooked or neglected by any person who would later seek to make himself acquainted with what had been done in the industry. From the first advertisement inserted in the pages of the old *Operator* down to the current issue of its lineal successor, the ELECTRICAL WORLD AND ENGINEER, with its 196 pages of advertising in the single issue—high-water mark in electrical advertising in America—the stream of history is unbroken, and all the points of advance are sharply and strikingly defined. We would not like to say that if the reading pages were omitted the art could still be

reconstituted from these advertising pages, for that would overlook the great development of engineering theory and scientific research out of which inventions grow; but it is nevertheless a statement capable of being sustained that every great outburst of inventive activity has made a clear and indelible imprint in those advertisements.

This is one aspect of the question of advertising, but there is another which is of vital importance to the manufacturer, and that is the success which should attend his efforts to reach the public and to market his goods. We must therefore take it to be a conceded fact that the notable extent to which the advertising pages of this journal have been used as a means of influencing trade has been found justified by those who have spent their money so liberally to secure publicity. And from the past we would derive a cheerful augury as to the future, for it is to-day better understood than it ever was at any time during the last thirty years that publicity must be sought scientifically, persistently and liberally. Each new development in electricity has required means for reaching the attention of a new set of customers, but the great broadening out of the area of contact with the public thus necessitated has, we believe, found this journal ready for the test and equal to it. In fact, it is no presumption to say that in some respects and very often this journal has had to advocate causes that appeared like forlorn hopes, and to keep hammering away at developments which it seemed would never "arrive." But as Mr. Ayer has pointed out in his interesting article, it has been strange how few of the electrical inventions up to date have failed to justify the hopes of their partisans and promoters, and this we feel must be attributed in very large measure to the publicity and advertising that has been secured.

If we were to want a justification of our point of view we could desire no better proof than the article which Mr. Arthur Warren has recently contributed to one of the New York dailies. This gentleman, as is well known, was for some years past at the head of the advertising bureau of one of the largest electrical corporations in this country, and his whole article is an insistence upon the necessity of advertising and the remarkable gains which follow judicious expenditures. As he says, "There was a time when good wine needed no bush; when great industrial concerns scorned publicity; but competition has changed the conditions in the last half-dozen years." Every one familiar with the field of industrial development must recognize the truth of this, but it seems to us that very few men yet, in the electrical field, realize how largely their business could be built up beyond its present figures by aggressive campaigns of publicity. As Mr. W. F. White points out elsewhere in his suggestive remarks on the growth of the sale of current, the gross receipts from the use of electrical energy for all purposes do not exceed at the most $2 per capita per annum in our largest cities, and he insists that such figures can be increased four or five fold. We believe with him that they can, but it will not be done without methods of publicity far exceeding in boldness and vigor anything yet witnessed by ourselves or our readers.

The Loading of Telephone Circuits.

We give this week an account of the most recent work accomplished in the direction of improving and extending telephonic communication by the aid of the Pupin system of inductive loading of telephone circuits. The work is evidently in steady progress. It is clear, however, that in spite of all benefits thus far derived, or immediately in sight, we must not expect to talk from New York to London, or to Brisbane, Australia, just yet. Every year makes the need of loaded conductors more apparent. The cities are building out into the country and extending their limits. They insist, and the very necessities of construction likewise insist, that the telephone wires shall go underground. As soon as the wires go underground the added resistance and capacity of the cables greatly reduce the volume and clearness of the telephonically-transmitted speech. A few miles of underground cable are harder to talk through than a thousand-mile air line from New York to Chicago. The loading of underground circuits comes to the rescue under these circumstances, and mitigates the difficulties with the stretches of cable in the limits of terminal cities. No doubt it will some day be necessary to load all underground telephone wires, as a matter of standard practice and general necessity.

Electric Railway Growth.

It is an extraordinary fact, for which we have never seen any adequate or satisfactory explanation, that the electric railway—the latest comer amongst the great electrotechnical industries which grew up during the past century—has far exceeded in importance and magnitude of investment the others which preceded it. It is also a singular fact still remaining to be elucidated that the industries have been successively larger in the order of their creation and progression, telephony being in excess of telegraphy, electric lighting larger than either of them, and the electric railway the biggest of the lot. In fact, according to the authentic figures now available, the electric railway with a capital investment of $2,500,000,000 is more than equal to all its predecessors put together, which at the most could hardly be set down for much beyond $1,750,000,000—itself no slight item.

Our present issue contains amongst its memorial and reminiscent articles, several dealing with the crude and humble beginnings of the electric railway industry in the United States now represented by such an enormous aggregate of capital. We are able to present from those who actively participated in the stirring events of the 80's, very interesting stories as to what was done on the early Daft, Van Depoele, Sprague, Bentley-Knight and other pioneer roads of the period. We are sure that anyone who reads those articles, as all doubtless will, would hardly believe it unless they knew it to be so, that from such unpromising commencements has been built up the art which at this moment has begun to claim also for its own the vast domain that has previously acknowledged only the sceptre of steam. The figures, for example, which General Griffin, himself one of the pioneers, gives in his article, are simply astounding, for the same man who made the first governmental report on the subject is able also to tell quietly, almost as a matter of course, how from 100 cars electrically equipped in '87, a total of 55,000 cars electrically equipped has been reached in 1903; while the outfit per car has advanced from 10 hp up to 2,250 hp each for the electric locomotives on the New York Central system.

It is interesting also that our present issue should contain two such unusual articles as that by Mr. Frank J. Sprague on his own work and the outlook for the future, and that on the Ward Leonard pioneer work, on single-phase traction, which now beckons so hopefully as one of the means by which the heavier work ahead has to be done. The two points of view presented in these two articles are most striking and interesting. To us they do not suggest the idea of conflict at all, but rather proclaim the flexibility and resourcefulness of electricity with its two forms of current, the direct and the alternating; one of which has already done such magnificent work, and the other of which justifies such sanguine expectations as to its accomplishments in the near future. The discussion by Mr. Sprague of the features of advantage and utility in connection with the direct current is singularly timely and most felicitously put, and we know that it will enjoy the attention it so well deserves.

THE NEWER ARTS.

The contents of the present commemorative issue of this journal deal largely with the electrical arts now in prosperous existence and with the stages by which they have successively been brought into being. The very number and magnitude of these industries created during the past thirty years make us wonder a little as to what may be the newer arts and industries which the next thirty years will see in the electrical field. Prophecy is rather dangerous and difficult in regard to electricity where so many things crop up unexpectedly, but there are those who are willing to try their hand, as for example, Mr. Tesla, whose article alone would give distinction to our current number, by its bold vaticinations. If all he says and believes were to come true, there would indeed be a crop of new arts to stagger the world with.

Aside from prophecy, however, and the results that might be reasonably expected from such progressive work as that with radium, it would seem that there is reason for hope attending developments within the immediate range of practicality. Wireless telegraphy is certainly proving itself capable of becoming a great industry, and opposed to that we have the bright promise of long-distance and submarine telephony. In the domain of heavy work there is every reason to believe that telpherage may build up an industry equalling in the actual amount of hard work done whatever is now accomplished in street railways. Electric heating is also showing itself capable of indefinite extension, as evidenced by the remarkable plant which we described recently in the Government Printing Office at Washington. There would also seem to be hope in electric canal haulage, and certainly some in the transportation of mail and other matter through tubes in city streets and from one part to another of our huge modern office buildings and factories. These and other fields to occupy, to say nothing of the conversion of the steam railroads, stretch before the eager electrical engineer. Particularly in electrochemistry and electrometallurgy, as pointed out in the admirable article by Dr. Roeber, may we expect to see new and valuable arts arise. But even if no new developments impended, the growth of wire telegraphy, of telephony, of electric lighting and power, and of street traction, as well as of other well-established arts, would provide abundant occupation for every man now enlisted under the electrical banner.

THE LIGHTING OF THE FUTURE.

It is with no prophetic instinct that we would seek to forecast the immediate future of the art which has won so great a place in the thirty years past, nor do we propose to indulge in iridescent dreams of what may come to pass if the hopes of inventors are fully realized. We wish merely to point out some of the salient facts that confront us as auguries of work for the next generation. To view the situation soberly, neither electric lighting nor any other single form of artificial illumination touches deeply the roots of human life and industry. The world would wag on in about the same old fashion if petroleum or coal gas, acetylene or electric light were forgotten. The abolition of any one of these would be, save for those immediately concerned in its production, a transition phase of fashion, and bring us back to early dinner hours. Of all known illuminants, electric light is easily the first from a hygienic standpoint, since the light is produced without sensible combustion. This virtue and its excellent color value conspire to give it a very strong hold on public favor, but as regards the former characteristic, few people are willing to pay, when in good health, any considerable price for hygienic conditions, and as regards the latter, it is fully equalled, for instance, by acetylene. In the last resort, therefore, the battle of illuminants resolves itself into a contest for economy, modified only by the dictates of fashion and external appearances. At the present time, electric lighting has the upper hand of its competitors, but it can retain it only by constant fighting. It has, of course, certain strongholds from which it cannot easily be driven, although the open field as a whole is for anybody's winning.

At the present time the electric arc is by a very perceptible amount the cheapest all-around illuminant, and this fact is the strongest ally of incandescent lighting. For, while cheap gas in mantle burners can undoubtedly beat out the incandescent lamp, candle for candle, in mere cost, it cannot meet the arc on even terms, and if the consumer is deaf to all arguments based on hygiene and color blind to boot, the central station still holds a trump card in the arc. The intensing mantle burners in their various forms can beat out the arc indoors, so far as price is concerned, but are at a disadvantage out-of-doors, and require some species of local plant which works to their disadvantage in the matter of convenience. It is safe, then, to say that the electric arc will keep a strong position among illuminants for a long time to come, and that it will be steadily improved along lines which are already blazed out. It is in the field of incandescent lighting that the fiercest battle will rage. In spite of all the experimental work of the past few years, the glow lamp retains its supremacy, and its reign is not yet even seriously threatened. Until the Nernst lamp runs without attention, and the vapor lamps cease to be green, these, the most promising recent innovations, will be seriously handicapped. Evidence goes to show that no amount of talking will persuade the general public that green is a desirable or becoming color for lights—or make it so. If argument could blind the eye to that uncanny shade, the mantle burner would long since have had the glow lamp "in chancery" in spite of every effort at defense. Let the vapor lamp once escape from the color difficulty, and it will immediately assume a most commanding position in the art, even if it should only be available in rather large units of great intrinsic brilliancy.

Two things we need in electric lighting for the immediate future. One is a lamp of moderate power, moderate intrinsic brilliancy, good color and high economy to replace or supplement the present glow lamp. The other is a very efficient lamp of almost any power and brilliancy, with plenty of red and yellow in its spectrum, and capable of operating when fully enclosed, and practically without attention. The first form of lamp has its obvious uses laid out in advance. The second would be almost equally valuable to the art, and could be utilized for indirect lighting with the greatest advantage. If the arcs with composite carbons could only be enclosed and run without attention, they would fill the bill exactly. But no form of arc yet devised can advantageously be employed as a concealed illuminant, and, however efficient, it is easily beaten out by the glow lamp for interior illumination. Almost any kind of illuminant will answer out-of-doors provided it does not require too much attention, but for the regular work of interior lighting the incandescent lamp fully holds its own, inefficient as it relatively is. Which of the suggested improved lights is likely to appear first, no one can tell; perhaps both may come together. The chances seem a little better for the first named than for a light of high power; and the futile efforts which have thus far failed to obtain either are evidence enough of the difficulty of the problem. Lacking these improvements, the best hopes of electric lighting lie in the skilful use of the illuminants that are now available, in a careful adaptation of means to ends, and in a realization that illumination is not a haphazard business where all the light that can be paid for is the proper amount to use. On the contrary, light improperly employed is not only useless but harmful, and one light well placed is better than two misplaced. If one can make ten common glow lamps do the work of fifteen as now used, he has scored as great a success as if he had installed a new form of two-watt lamp. The final test of lighting is light.

Civil Engineers to Stay Out.

The American Society of Civil Engineers, as the result of its ballot vote taken recently and canvassed this week, has decided not to join with the other national engineering bodies of the country in accepting Mr. Andrew Carnegie's gift of $1,500,000 to be devoted to creating a magnificent engineering home and center in New York City. The vote was decided by 1,134 against 662 for acceptance, or a majority of 472 against the plan. The Society has a membership of about 2,500, from which it would appear that no fewer than 700 members abstained from voting, or were indifferent to the matter.

It will be remembered by our readers that as an immediate result of the library dinner of the American Institute of Electrical Engineers held in February last year, Mr. Carnegie gave $1,000,000 to the four principal national engineering societies, namely, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers, as well as to the Engineers' Club, a social organization including members from all bodies; this money to be devoted to the erection of a building or buildings where all these bodies could be adequately housed. The Engineers' Club already had land on West Fortieth Street facing the new Lenox Library, and Mr. Carnegie immediately proceeded, therefore, to acquire land on Thirty-ninth Street so as to enable the proposed building for the engineering societies and the new building of the club to be placed in convenient juxtaposition. Up to the present time he has spent in the vicinity of $600,000 in thus acquiring land for the benefit of the four engineering bodies named, three of which as well as the Engineers' Club, have already accepted Mr. Carnegie's gift.

A reconsideration of the plans and the fact that if the Civil Engineers came in quarters would be needed for not less than 12,000 professional men and for societies all of which are growing rapidly, determined Mr. Carnegie to increase his generous offer; and with characteristic promptness and liberality he added half-a-million dollars to the sum which he had originally designated, intimating as he did so that his great aim and ideal in doing this was to foster fellowship and promote union and harmony amongst the engineering professions; so that all while maintaining their individuality could work together for the common good. As will be seen, however, the Civil Engineers, who already have a house of their own on West Fifty-seventh Street, have now decided to stay there alone and isolated, although as their recent annual meeting proved, it is much too small for their purposes, so that the very meeting at which the ballot vote was decided upon had to be held in the Carnegie Lyceum adjoining.

Our readers are well aware of the fact that immediately following the announcement of Mr. Carnegie's gift a conference committee of fifteen was formed with three members from each of the five bodies interested. It would appear from this vote that the delegates of the Civil Engineers are no longer authorized to participate in the proceedings of the conference committee. Mr. Carnegie and the three societies, which have already voted to accept his gift, and which, with the Engineers' Club, number some 8,000 or 9,000 members, will possibly have to change their plans and adjust them to the conditions which have arisen from this action of the Civil Engineers. It is needless to say that the attitude of the members of the Civil Engineers who voted against what are regarded as broad, common interests is viewed with deep regret by electrical engineers, who looked forward eagerly to closer co-operation with the Civils, but who find some consolation, however, in the fact that after all less than half the members of the society recorded an unfavorable vote. The results of this action will be followed with the greatest interest by engineers all over the world.

In the meantime, the American Institute of Electrical Engineers, realizing that whatever might be the course of events, it would have to call upon the generosity of its members in order to be able to assume new liabilities and larger responsibilities in safety, has, with its wonted vigor, lost no time in getting itself into a position where it could command resources of its own at least equal to those of any other society. During the past few weeks, therefore, its Land, Building Fund and Endowment Committee has gone to work, and from perhaps not more than a hundred of its members it has already secured donations and pledges of $40,000. When it is considered that the membership is 3,000, it will be seen that the committee is warranted in its hope of raising at least $150,000 from the members; and not less than $50,000 to $100,000 is expected from the corporations and manufacturers in the industry benefitted by the Institute work. The Institute thus fairly expects to be in a financial position equal to that of any other kindred society, and adequate to the purchase of land for any kind of a building Mr. Carnegie may put on it.

The Chicago "Tech." Dinner.

The Northwestern Alumni of the Massachusetts Institute of Technology held a dinner February 27 at Chicago, which proved to be an affair of considerable electrical interest. Mr. V. R. Lansingh, the well-known illuminating engineer of Chicago, who is secretary of the alumni association and made the preparations, had a surprise in store. When the guests entered the banquet room at the University Club they found it illuminated with six 750-cp Cooper Hewitt mercury vapor lamps. This was the first opportunity the majority of those present had had of testing the qualities of the mercury vapor lamp for general interior illumination. The lamps were turned off during dinner, but were turned on again by way of introduction to the after dinner remarks of Professor W. E. Goldsborough, who told of some of the new things in the electrical line to be at the coming St. Louis World's Fair. The mercury vapor lamp in several forms, he said, was to be one of the new features. He spoke of some decorative lighting in colored lights which would be different from the decorative lighting of previous expositions. Wireless telephony, he said, was another new feature that would probably be shown, and several of the new single-phase alternating-current railway motors would be on hand.

Reception Committee for the Congress.

President Bion J. Arnold, of the American Institute of Electrical Engineers, has appointed the following general reception committee for the International Electrical Congress this year: John W. Lieb, Jr., chairman, 55 Duane street, N. Y.; Calvin W. Rice, vice-chairman, 348 Central Park West, N. Y.; E. G. Acheson, E. K. Adams, William A. Anthony, A. H. Armstrong, J. C. Barclay, Alex. Graham Bell, Louis Bell, Charles S. Bradley, N. F. Brady, C. F. Brush, H. W. Buck, George Bullock, H. S. Carhart, J. J. Carty, C. A. Coffin, C. D. Crandall, F. B. Crocker, H. L. Doherty, Alex. Dow, Louis Duncan, Gano S. Dunn, Thomas A. Edison, Charles L. Edgar, W. C. L. Eglin, R. A. Fessenden, S. D. Field, Frederick P. Fish, B. Gherardi, W. E. Goldsborough, Hammond V. Hayes, Carl Hering, Peter Cooper Hewitt, J. W. Howell, C. R. Huntley, Samuel Insull, D. C. Jackson, William J. Jenks, Francis W. Jones, John F. Kelly, A. E. Kennelly, W. A. Kreidler, H. Ward Leonard, Herbert Lloyd, T. D. Lockwood, John Martin, T. C. Martin, J. H. McGraw, E. L. Nichols, R. B. Owens, F. S. Pearson, W. A. Pearson, F. A. C. Perrine, Ralph W. Pope, W. V. N. Powelson, Charles W. Price, M. I. Pupin, Samuel Reber, E. W. Rice, Jr., A. L. Riker, E. B. Rosa, Charles F. Scott, Samuel Sheldon, Frank J. Sprague, William Stanley, C. P. Steinmetz, L. B. Stillwell, H. G. Stott, F. H. Taylor, Charles A. Terry, Nikola Tesla, Elihu Thomson, Calvert Townley, W. D. Weaver, George Westinghouse, Edward Weston, Schuyler S. Wheeler, J. G. White, W. F. White.

Coming Electrical Meetings in Chicago.

The electrical section of the Western Society of Engineers (formerly the Chicago Electrical Association) will hold a meeting March 18 at its rooms in the Monadnock Building, for the discussion of the "Electrical Opportunities in Chicago." George A. Damon, who will be the leader of this discussion, has sent out inquiries for reports from 100 of the best-known young electrical men of the city, inquiring as to education, training, opinions as to what constitutes the best preparation for an electrical career, and other matters throwing light on the subject. Mr. Damon has received replies from a large per cent. of those from whom this information was asked, which would indicate that the subject is one of general interest and one which will be productive of an interesting meeting. The Chicago branch of the American Institute of Electrical Engineers will have a meeting for the discussion of the single-phase alternating-current railway motor on March 8, at the rooms of the Western Society of Engineers.

Electric Lighting in the City of Benjamin Franklin.

By W. C. L. Eglin.

FIG. 1.—STACK 275 FT. HIGH.

THE city of Philadelphia comprises an area of over 129 square miles, and the demand for current comes from all quarters of the city. Formerly, there were 27 companies with 18 different operating companies distributed throughout the city and suburbs, each of the companies operating on an entirely separate and independent basis by reason of its franchise, and thus preventing a consolidation of organization and operation similar to other large cities. The distribution of current by these various companies included practically all of the methods used commercially, viz.: direct current of 500-volt two-wire, 110-volt two-wire, and 220-volt three-wire systems; also single-phase alternating current, two-phase alternating current, and three-phase alternating current, with frequencies of 60, 66, 125 and 133 cycles. The voltages of the alternating-current feeders were 1,000 to 1,200 and 2,000 to 2,400 volts. The total number of consumers of these various companies was over 13,700, using 13,973 series arc lamps, 3,758 incandescent lamps, both direct current and alternating current, 16,000 hp in motors, and 494,000 incandescent lamps. The total equivalent connected load in 16-cp lamps was 878,000. The yearly kw-hours manufactured at these various stations were 59,405,970, divided as follows: Incandescent and power, 35,081,545; arc, 24,324,425. It was such a system that had to be unified and harmonized.

In the consolidation of a number of electric lighting and power properties, the first essential is a uniformity in the supply of current to the various consumers. Conditions existing in Philadelphia were similar to those in other large cities in which are located a number of small plants, some supplying alternating current and some direct current—those supplying alternating current having a voltage differing somewhat from the latter. Before, therefore, effectual consolidation could be made of the operation of these plants, attention was given to the distributing system; and after a careful study of the situation it was decided to adopt the two-phase 60-cycle alternating-current distributing system for most of the territory, and the direct-current, 220-volt, three-wire system for the principal business section of the city. This simplified the generating station as it required only one type of generator to supply directly all of the alternating current, and indirectly the direct current by means of high voltage alternating-current motors and 300-volt direct-current generators.

The entire distributing system was reconstructed so as to obtain a uniform primary and secondary distribution, and change the single-phase to two-phase circuits. All primary circuits were arranged for voltages ranging from 2,200 to 2,400 volts, and secondary, from 110 to 120 volts. Tie lines were installed between the various distributing centers, these tie lines being operated at 5,500 volts, which is the voltage of the generating station.

After the completion of the plans for the distributing system, a careful survey was made of the property on both the Delaware and Schuylkill Rivers to obtain a site for the main generating station. After examination of the properties obtainable, preliminary plans were made showing the ultimate capacity to be obtained on the properties. These plans were submitted to Mr. John T. Windrim of the firm of James H. Windrim, Architect, Philadelphia, Pa., who prepared the plans of the first section of the building. In selecting the site for the main generating station it was essential that enough ground be obtained to admit of an increase of at least ten times the first necessary equipment, so as to take care of any increase in capacity required for the large growth of the business during a period of years.

The site finally selected is, for many reasons, probably ideal. The total area is about nine acres, extending from the Schuylkill River front a distance of 1,304 ft. without being divided by streets. The actual distance from the central station to the center of the load district is about three miles. This property is bounded on the one side by the Pennsylvania Railroad and on another by the Baltimore & Ohio Railroad, and on the other side by Christian Street, a broad and well-paved street.

For the reasons above mentioned, it was decided to design the station on a sectional plan in order that it could be extended in one direction to the end of the building lot, each lineal foot of station giving a proportionate increase of switchboard, engine room, boiler room and auxiliary capacity. This necessitated that all of the apparatus be laid out in parallel lines, and the crossing or mixing of various classes of apparatus prevented by careful attention to details.

The first section of the building was located 360 ft. from the river in order to admit of an arrangement of coal storage at both ends of the complete plant. Fig 8 shows the survey plan of the property. It will be seen that this property is somewhat triangular, and that the width of the property increases eastward. The first section of the building was naturally located nearest the river.

The generating station consists of two buildings, one a boiler room and the other an engine room arranged with a number of mezzanine floors for switchboard galleries. The smoke-stack was placed outside of the building, first, to avoid taking up space in the building required for boiler purposes, and, second, the space was available outside and could be utilized to no better advantage.

The first work was arranging the foundations of the building, and the intake and discharge water conduits for condensing purposes. It was decided to arrange the intake and discharge conduits triangularly and construct them of concrete which would fulfill the function of foundations for the division wall between the engine room and the boiler room. The reasons for establishing this location was that water is required in both the engine and boiler-room

FIG. 2.—GENERAL VIEW OF CHRISTIAN STREET STATION, PHILADELPHIA.

buildings, and connections could readily be made to both sides of this conduit. The placing of the conduit in any other location would necessitate carrying the foundation for the columns of the building on either side down to a lower depth, thus increasing the cost. The arrangement of the conduits permitted of the desired capacity with minimum depth of excavation. The two lower intake conduits are each 7 ft. in diameter and joined with cross-connections of 4 ft. at frequent intervals. The discharge conduit is elliptically shaped, being 12 ft. in height by 8 ft. wide. Connections to the intake conduit are made by walls so that the intake pipes can be dropped down and be continuously submerged. The top of this conduit was

entirely covered with 20-in. I-beams; and at the points where the columns rest, additional I-beams were placed across those upon which the bolsters rest, so that the load was distributed uniformly over the entire length of the conduit.

On account of the elevation of the ground towards the east, it was decided to make the engine room floor at the street level towards the middle section of the building, so that in the first section of the building there would be no basement, the basement being on the ground level about 6 ft. above high water.

It was decided to install as a unit generator the largest size to be obtained commercially, although at first a unit of one-half size was installed so as to operate economically at the light loads during the period of the growth of the load on this section. For these reasons 5,000-kw units were decided upon as the standard, and 2,000-kw units were installed as the half unit. Both of these units have an overload capacity of 50 per cent. for two hours.

The General Electric generators are revolving field, two-phase, 6,000 volts, excitation being provided by motor-generator sets. The motors, which are of the induction type, are wound for 6,000 volts, two-phase, the direct-current generator being wound for 300 volts.

A small steam exciter set is used in the event of the station being unable to obtain current from tie lines when starting up. These exciters are placed on the engine-room floor. On the first mezzanine floor are placed the direct-current switchboards for exciters, the oil switches, and the series and potential transformers. On the second mezzanine floor are the reserve oil switches, one of which is always in series with the switch on the floor below, and is also used as a selector switch for each of the bus-bars, the bus-bars being arranged in separate concrete compartments on the upper mezzanine floors, and the controlling board being located on the second mezzanine floor.

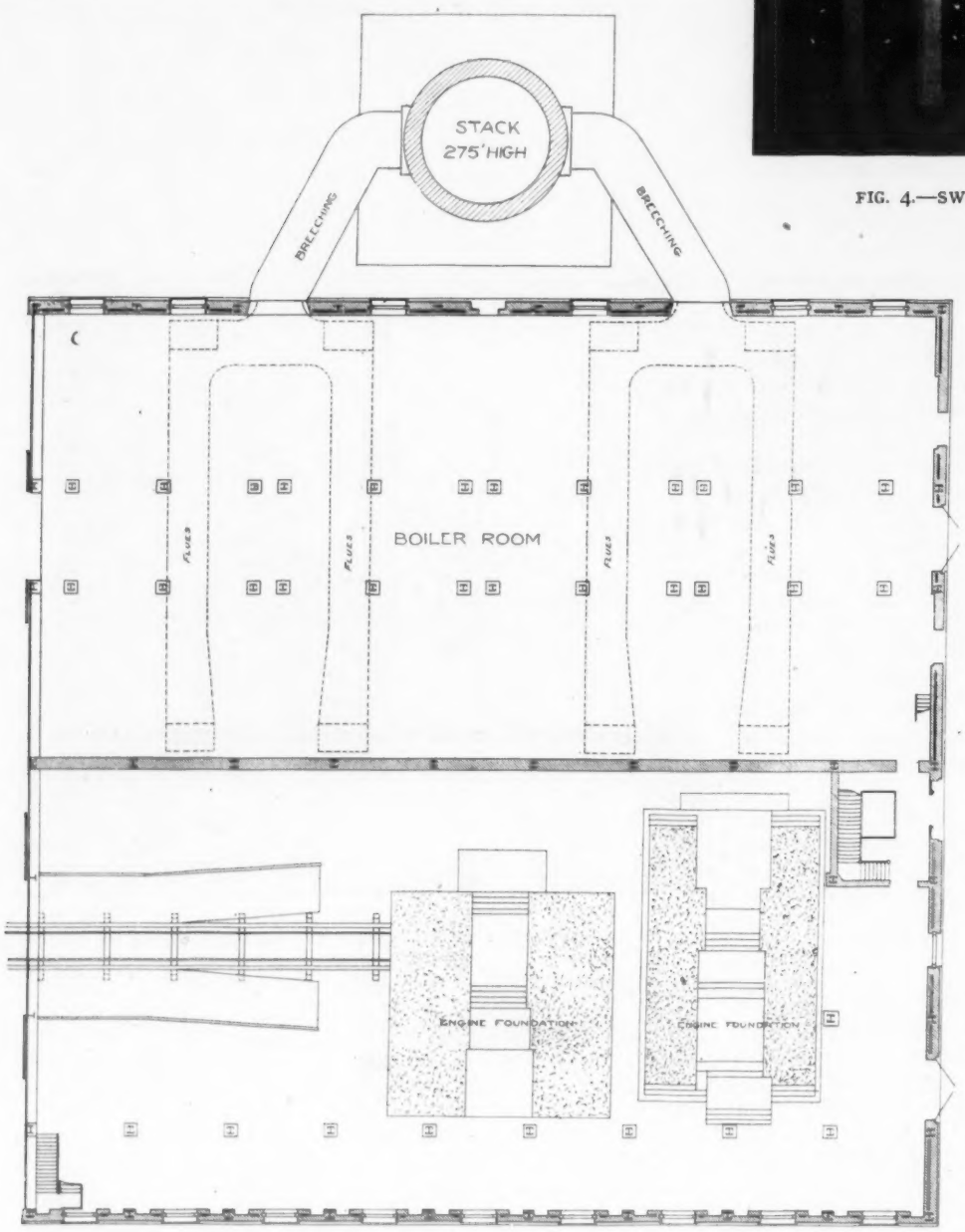


FIG. 3.—BASEMENT PLAN OF POWER HOUSE.

The boiler-house building consists of an arrangement for double-decked boilers with coal storage above the boilers and a common ash floor for both floors of boilers. The basement or ground floor is arranged to receive all of the ashes, each boiler being provided with a cast-iron sectional ash pit, and connections can be made between the combustion chamber and the ash pit for the ready removal of refuse material. On the side adjoining the engine room is situated a pump room in which are located the tank, pumps, boiler feed pumps and feed water heaters. The basement has a height of 18 ft., which admits of the use of almost any type of auxiliary apparatus without crowding. The flues of the first boiler room floor also pass through the basement to connect with the chimney, thus leaving the boiler room clear of any obstructions.

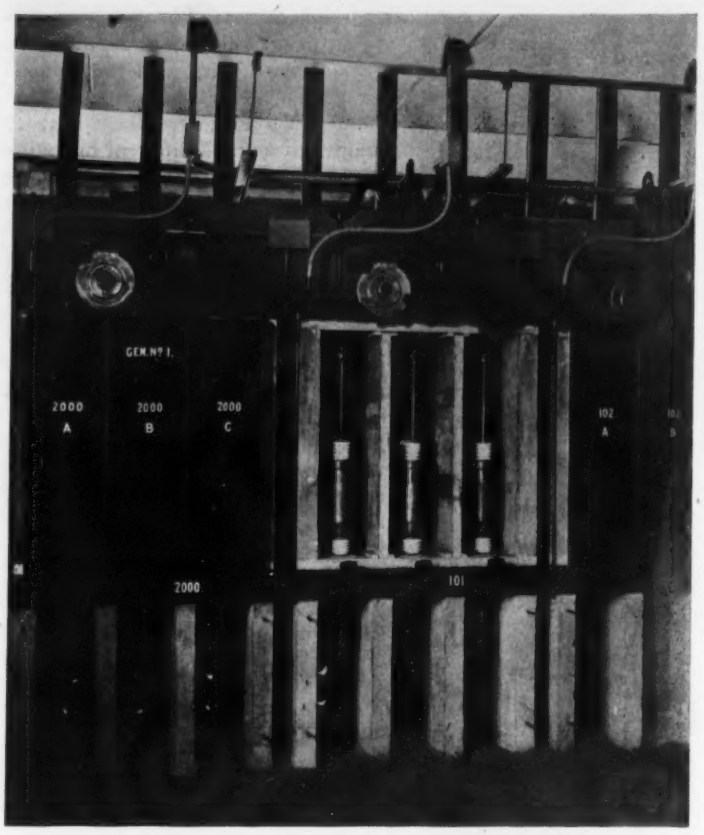


FIG. 4.—SWITCH COMPARTMENT, FIRST GALLERY.

In the first section of the building will be installed 32 boilers approximately 630 hp each. These are arranged in batteries of two, and are so set that all walls may be easily examined. The boilers are equipped with a complete double system of feed water supply, the first from the hot water feed water system, and the second by individual injectors for each boiler connected with tanks, placed above the boilers—the injectors being intended for emergency use only. Special care has been given to the installation of the feed water piping, fittings being avoided whenever possible, and bent brass pipe used.

Coal is supplied by means of chutes arranged close to the columns, the spout being bent in order that the coal can be dumped on the center of the floor should it be required.

The second boiler room is a duplicate of the first boiler room with the exception that the flues pass up and through the coal-bunker floor to reach openings in the stack, provided at this point.

The coal-bunker is divided into pockets, first to admit of the flues passing across the building; and second, to prevent fire from being communicated from one portion of the coal-bunker to an-

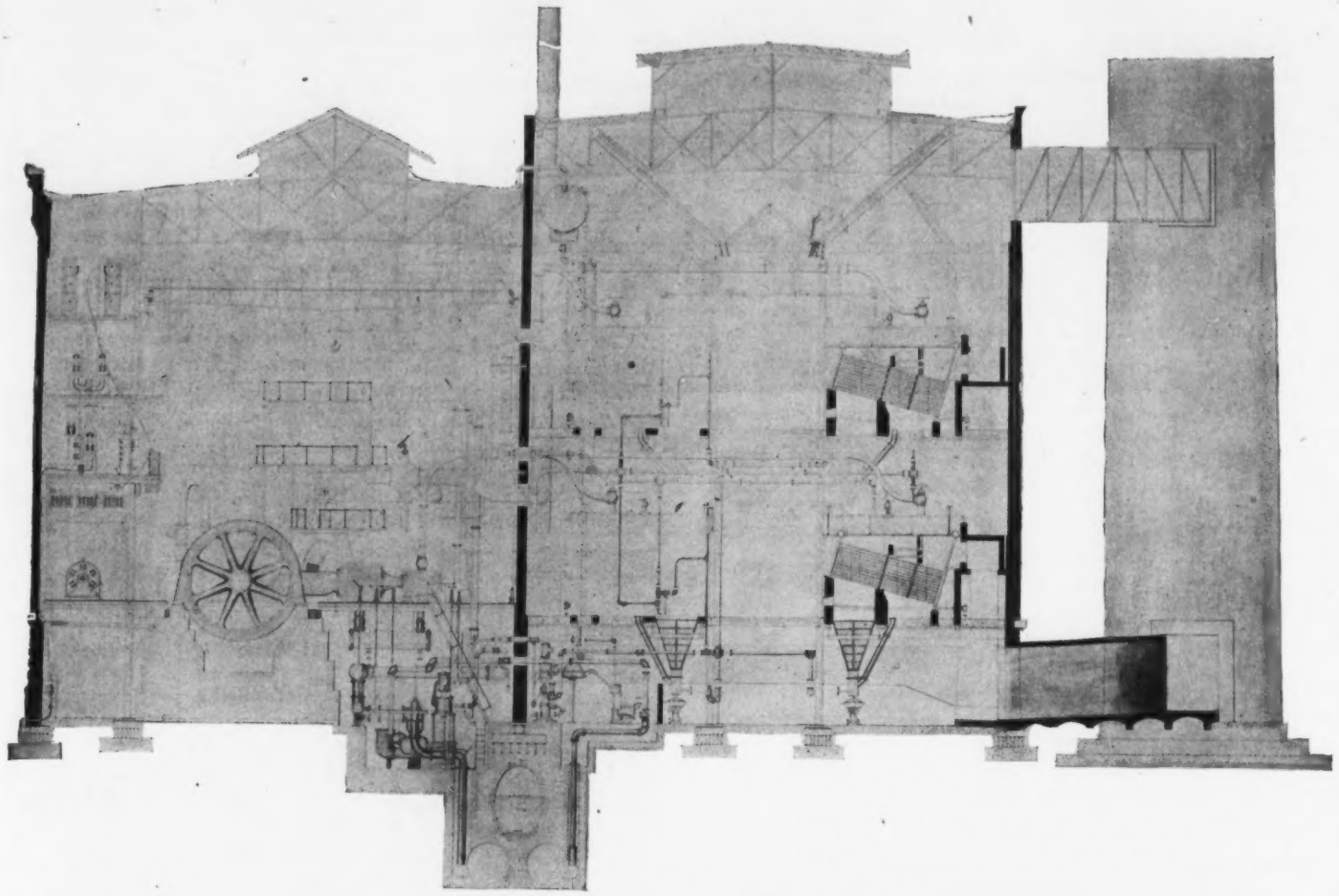


FIG. 5.—CROSS-SECTION VIEW OF STATION A, CHRISTIAN STREET, PHILADELPHIA.

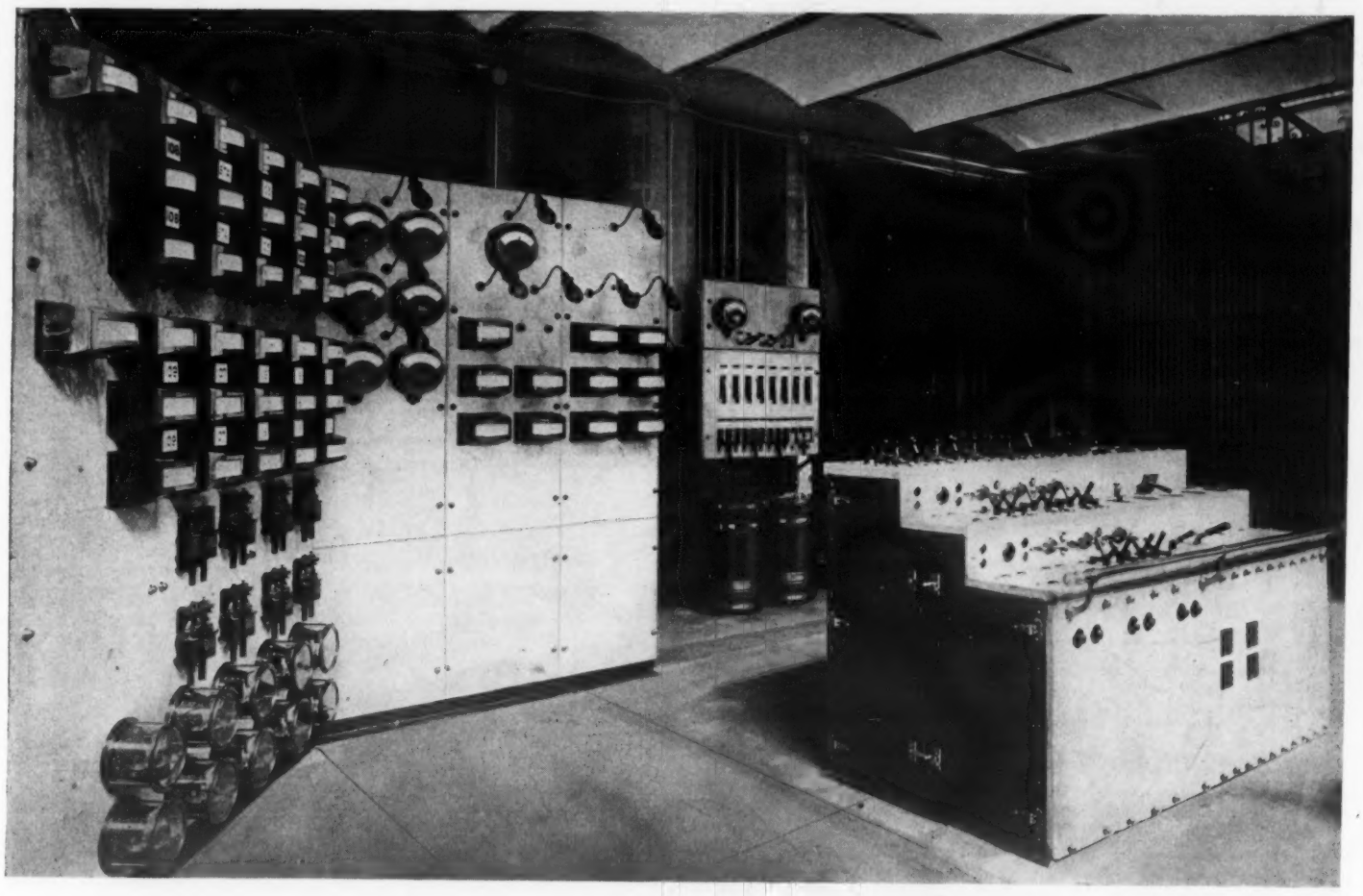


FIG. 6.—OPERATING TABLE AND FEEDER AND INSTRUMENT PANELS.

other, thus entirely obviating the danger from this cause. Should the coal ignite from any cause, the pocket could immediately be drained on either of the boiler-room floors.

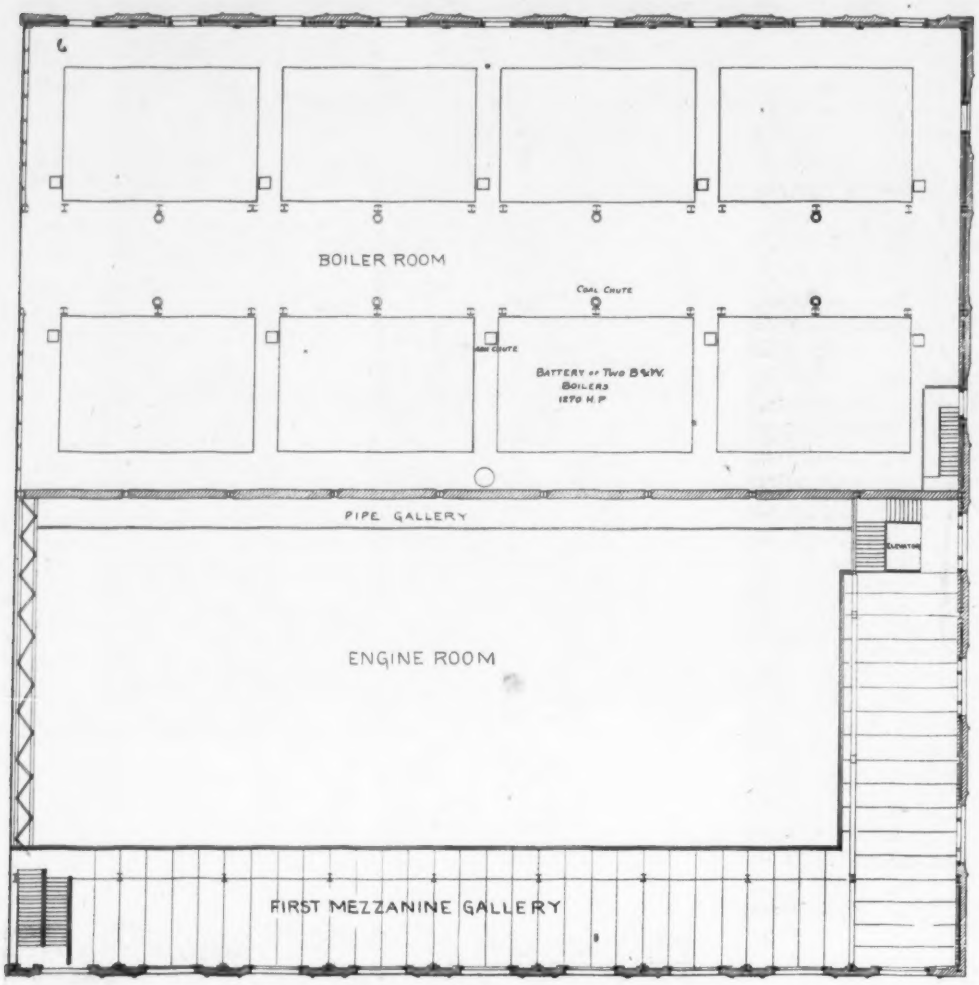


FIG. 7.—FIRST FLOOR PLAN OF POWER HOUSE.

tween the coal-bunkers and the roof is provided with a liberal number of copper louvres so as to admit of ventilation. Each space above the flue-crossing is provided with a "Star" ventilator. All stairways are metal, and strict attention has been given to making the building as nearly fire-proof as practicable. All the doors between the engine room building and the boiler room building are standard Underwriter fire-proof doors.

The engine room building, which fronts on Christian Street, is similar in external appearance to the boiler room building, both being built of red stretcher brick and the general design consisting of large panels arranged between the structural steel columns, this being an inexpensive but ornamental design. The panels in the boiler room building are partially bricked up and the engine room walls are almost entirely utilized for windows, making a very light engine room. The engine room is further provided with a lantern extending along the engine room proper. The lantern is laid with wired glass, the glass overhanging the removable ventilating sash, so that in the event of a heavy wind or rain storm it is not necessary to close the ventilating sash.

All of the metal work exposed to the weather is covered with sheet copper, including the cornices and rain spouts, it being the intention that the building is to be as permanent and lasting as possible. The engine building is lined with light-colored enameled brick to six feet above the engine floor, the other part being buff color.

The mezzanine floors are provided with heavy solid balustrades, which prevent material from dropping through, and would admit of these floors being enclosed should it be found desirable. The switchboard and all its appliances are arranged in the various mezzanine floors on the Christian Street

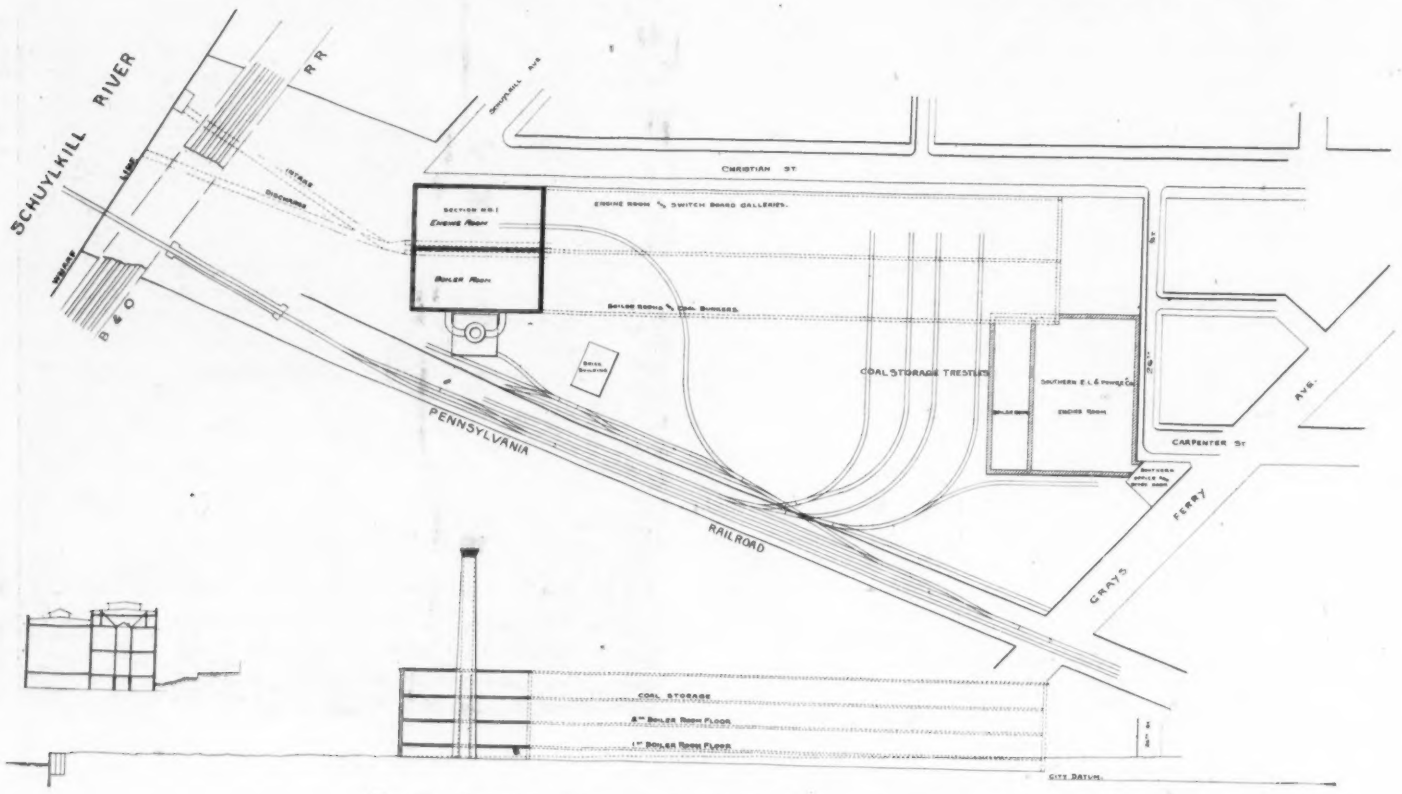


FIG. 8.—PROPERTY PLAN, PHILADELPHIA ELECTRIC COMPANY.

Coal is delivered to the coal-bunker by means of two bucket elevators at the end of the building and distributed by two horizontal conveyors running above the coal-bunkers. The space beside. The floors on the end facing the river are used for offices, storerooms and executive purposes.

Referring to the floor plan, it will be noted that in the boiler-room

the boilers are first arranged in batteries of two, and the batteries facing each other are connected to steam pipes which in turn feed the main header which is located on a division wall on the engine room side. This main header is arranged zigzag fashion; one section joins two batteries on one floor, rises and joins two batteries on the floor above. In this way the expansion and contraction of the main header is taken care of, and the line is always exposed to view. All joints are readily accessible, as permanent iron galleries are arranged parallel with the steam pipe.

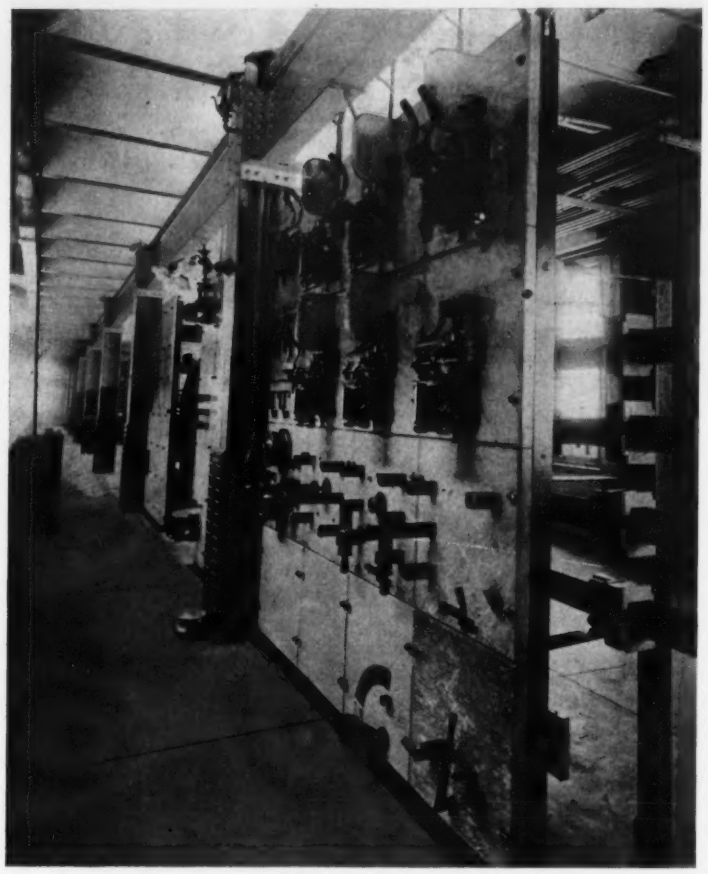


FIG. 9.—DIRECT-CURRENT AND EXCITER SWITCHBOARD.

The condensing apparatus is arranged on the boiler room side of the engine room and the auxiliaries are placed in the basement, this position making them adjacent to the auxiliaries for the boiler room, but separated from them by the division wall. They are, however, readily accessible on account of the doors placed for this purpose.

The 2,000-kw unit is driven by a cross double-tandem compound Wetherill Corliss Engine. The 5,000-kw unit is driven by a combined vertical and horizontal double-compound Reynolds-Corliss engine built by the Allis-Chalmers Company. The condenser for the 2,000-hp unit is of the jet type, and for the 5,000-kw unit is a Weiss injector condenser.

Special effort has been made to simplify the installation of the cables and electrical equipment and to keep the steam and electrical equipment entirely separate from each other, so that the steam pipes shall not cross the electrical conductors or vice versa. Cables immediately upon leaving the generators enter a terra cotta conduit and are conducted through continuous terra cotta conduits to the terminus. There are two sets of cables which should receive consideration, first the cables running from and to the generators, and second, the feeder cables leaving the station.

The feeders are distributed along the entire length of the Christain Street side. These cables are arranged in groups of six, and enter separate manholes distributed along the street front of the building, so that there is no bunching of cables in any manhole. The first conduit laid consisted of twenty-four 3½-in. terra cotta conduits. Drawings were prepared showing the layout of each cable from the station to the sub-station. The manholes were designed specially so as to admit of easy access to the cables, and at the same time protect the cables in the event of either gas explosions in manholes or short-circuits of adjacent cables. The manholes are of octagonal shape, and are provided with soapstone shelves which fulfill the function of supporting the cable and acting as a barrier, so that a short-circuit in one cable cannot be communicated to its neighbor. The conduit is spread at the point of entering the manhole so as to bring the end of the duct in line with the shelf upon which the cable will rest. This prevents any sharp bends and admits of cables being installed in a safe and convenient manner.

The station terminal of the cable is on the ground floor and consists of a series of concrete cells, the cable being provided with a pot-head at this point and spreading from a three-conductor cable to single-conductor cable. In these compartments are placed single-pole disconnectors. These disconnectors are similar to knife-switches without handles, and arranged to be opened with a detachable rod. The object of these disconnectors is to enable the cable department to know that current is not thrown on the cable when out of service and under repairs. Immediately above these compartments are placed static discharge devices which consist of an arrangement of spark gaps and graphite resistances similar to lightning arresters. They are protected by means of a small enclosed fuse and are enclosed in cases to keep out the dust. From these compartments the cable enters a terra cotta conduit which passes through the engine-room wall, is then exposed to the first mezzanine floor, and enters the concrete compartments leading to the oil switches and to the transformers, both series and potential.

The arrangement of the switchboard is in three tiers. First, automatic switches, or what might be called the operating switches; second, the reserve switches, which are placed above on the bus-bars, which occupy the highest tier. The intermediate tier consists of two oil switches, one of which is connected to either bus-bar, so that at all times two oil switches are in series.

Connections to the bus-bars are made with disconnectors similar to those used in cable compartments on the ground floor, so that it is unnecessary to remove any bolts or fastenings to disconnect any line from the bus-bars or from the outgoing feeders. This arrangement also enables the generators to be connected to any point of the bus-bars, minimizing the amount of copper used for that purpose. All of the switches are of the remote control type, an operating table being placed on the intermediate gallery.

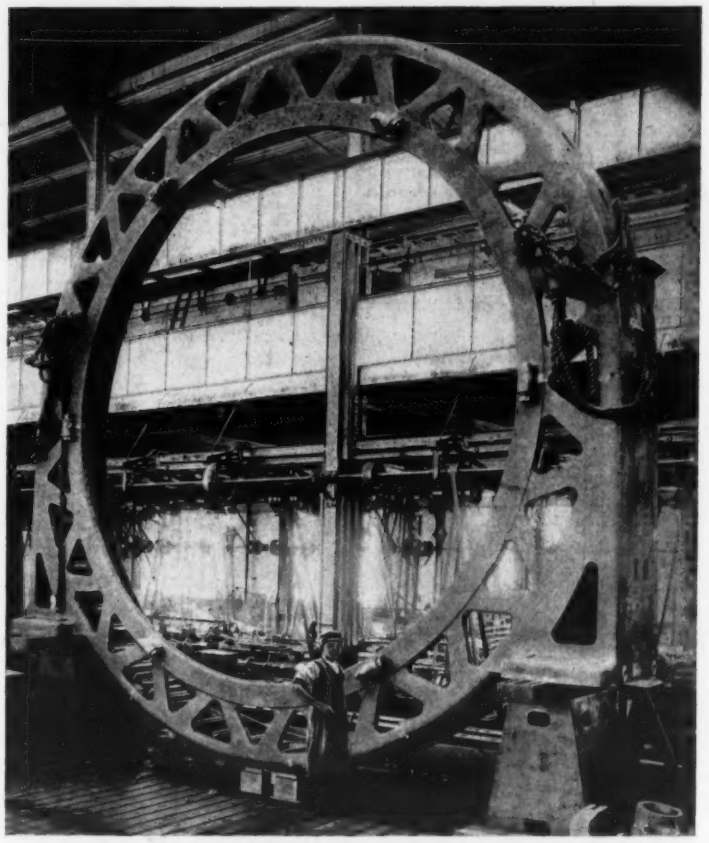


FIG. 10.—ARMATURE FRAME OF 6,000-VOLT GENERATOR.

The oil switches and high-tension bus bars are all arranged in concrete and soapstone compartments. As each switch section is a unit, and practically all of the units are similar, the concrete type

of construction permitted the same moulds being used for building up all of the compartments. The switches were set sufficiently high from the floor to enable easy access to the base of the switch and prevent sharp bends of the cable. On the back of the switch compartments on the first gallery are arranged the transformer compartments, which are of similar concrete construction and separated by means of a concrete wall. Provision has been made to ventilate all of these compartments so that in the event of an arc being formed, the flame will pass out through the vents, striking the division wall, and cannot be communicated to any of the other compartments.

The transformer compartment contains two series transformers and one potential transformer. The cases and frames of all of the transformers are grounded with heavy copper strips laid in the concrete. This copper strip is also connected to angle irons set in the concrete to which the various transformers are attached. One of the series transformers is used to operate the automatic switches by means of time, limit relays, and the other furnishes current for various indicating and recording instruments.

The potential transformer is of 600 watts capacity and is large enough to supply all pilot lamps and all indicating and recording instruments required.

All of the secondary wires from these transformers and the low-tension direct circuit supplying the motors operating the oil switches are installed in iron armored conduit, so that there are no exposed wires either high-tension or low-tension in the switchboard construction. All of the concrete compartments are provided with fireproof doors; and as the operating switchboard is entirely low-tension, being either the secondaries from the transformers or direct current supplying the operating motors, there is no danger from any cause to attendants, as in the event of failure and breaking down of the transformer the high-tension current is grounded through the strips provided for that purpose.

This table is arranged in steps similar to the keyboard of an organ so as more clearly to define the various groups of switches. Each feeder is controlled at this point by means of three switches, one automatic switch and two selector switches. These switches are provided with pilot lamps which indicate the position of the switch. The instruments are located on an instrument board immediately in front of the controlling table and upon this are mounted for each feeder a pilot lamp which indicates the number of the feeder, an ammeter and a recording wattmeter on each phase of the feeder. The generator control consists of the three switches. In this case all of the switches are hand-operated, no automatic switches being used on the generators. The main switch is controlled by a different type of handle to distinguish it from the selector switches. These are placed at the top of the table so as to be out of the way. On the next step is a switch to open the field circuit of the generator, and the switch for varying the speed of the engine for synchronizing. The lower step contains the field rheostat and synchronizing plugs. On the front of the table are the switches controlling the exciter sets. The indicating instruments on each generator are pilot lamps, voltmeters, ammeters and indicating wattmeters.

The instrument board is arranged with generator instruments and exciter instruments parallel to the control table, and the feeders are arranged on an offset at an angle of 45°, which concentrates the instruments and assists the vision of the operator as well as enabling him to differentiate between the different classes of instruments.

Cincinnati A. I. E. E. Local Meeting.

The February local meeting of the Cincinnati branch of the American Institute of Electrical Engineers was prefaced by a dinner at the Grand Hotel, at which 53 persons were seated. The meeting was held in the hotel auditorium, at which Mr. W. A. Blanck, of the Arnold Electric Power Station Company, read a paper on "Single-Phase Railroads." After outlining the various systems which have been tried—the synchronous motor driving a generator mounted on the train, the induction motor as a subdivision of this, the Arnold system of induction motor and air compressor combined, the alternating-current series motor, the repulsion induction motor as developed by Steinmetz and Schuler, and lastly the repulsio nseries motor of the Union Electric Company, of Berlin—Mr. Blanck took up the subject of controllers, car wiring, trolley bow and line construction. He then took a typical sixty-mile road equipped both by the present system of alternating-current generator with rotary converter, sub-stations and the system using transformer sub-stations and 3,000 volts on the trolley line. Comparing item for item he showed that the direct-current system giving the same service as a single-phase system costs 32 per cent. more than the alternating system. The paper was thoroughly discussed. At the next meeting it is hoped to have a paper on steam turbines.

The Development of Alternating-Current Work in America.

By Charles Appleton Terry.

Your request for reminiscences concerning the development of the commercial alternating-current system carries one's thoughts back to the early eighties when, though the direct-current system was in fairly extensive use, the alternating current had yet to receive the serious consideration of our engineers. Looking back over this period, the names of a few individuals stand out with peculiar prominence.

It is needless to say that the personality of Mr. Westinghouse is most conspicuously interwoven with the entire development of this system. When the work of Gaulard & Gibbs was first brought to his attention, he engaged the services of one of the most prominent of the electrical engineers of that time, Franklin L. Pope, a man whose quiet, forceful work aided greatly in the successful introduction of the alternating system to a skeptical public. Mr. Pope possessed an extraordinarily resourceful mind and a retentive memory stored with useful facts and apt information. His rare sense of humor and genial kindness of manner were combined with a persistence of will and untiring studiousness which had rendered him a recognized authority upon all electrical subjects; and to-day his publications upon telegraphy and kindred subjects are valuable works of reference. His railway signalling inventions had brought him into close association with Mr. Westinghouse, and it thus came about that in February, 1886, as a direct result of experiments made with the Gaulard & Gibbs system at Pittsburg in 1885, Mr. Pope went to England commissioned by Mr. Westinghouse to secure the American rights to the Gaulard & Gibbs system. Throughout the formative period of the system, Mr. Pope was closely identified with the patent and scientific matters involved.

The rapid march from the experimental plant of 1885, to the commercial plant installed at Buffalo in November, 1886, was largely to the credit of the engineering ability of Shallenberger, Stanley and Belfield. Within a year thereafter sixty-five plants were sold, representing a total generating capacity of 125,000 incandescent lamps. Almost immediately a strong opposition to the alternating system was developed by the partisans of the direct-current system, an opposition which though gradually lessened did not cease until the commercial advent of the rotary transformer or converter which wedded the two systems.

In the earlier days the alternating system was at first seriously handicapped by the lack of a meter and a power motor. In April, 1888, Shallenberger, while experimenting with an arc lamp, noted a peculiar action of a small coiled spring which accidentally lodged on the brass flange of the magnet spool; the spring slowly turned about its longitudinal axis. From this accidental circumstance Shallenberger within a month developed his alternating-current meter, which for nearly ten years was the principal recording meter for this system, the only other commercial one being that devised by Prof. Elihu Thomson, who also made important inventions in the alternating-current field.

The requirement of a motor was met by Tesla's discoveries, the public announcement of which was nearly coincident with the independent discovery of Shallenberger and the publication of Ferrari's work along similar lines. Tesla's discoveries, however, included the polyphase system, which lent itself more perfectly to the distribution of large power units.

There still remained the requirement of a power motor adapted to railway service, and this is now being met by the assured single-phase motors of Lamme and Steinmetz.

It would seem that as a result of this perseverance of those interested in the alternating-current system, the perfection of the detail apparatus and the growing appreciation of its possibilities, the handicap now rests upon the shoulders of the direct-current system rather than upon that using the current which Shallenberger once described as "the electric current as God gave it to us."

The Transmission of Electric Energy Without Wires.

BY NIKOLA TESLA.

IT is impossible to resist your courteous request extended on an occasion of such moment in the life of your journal. Your letter has vivified the memory of our beginning friendship, of the first imperfect attempts and undeserved successes, of kindnesses and misunderstandings. It has brought painfully to my mind the greatness of early expectations, the quick flight of time, and, alas! the smallness of realizations. The following lines which, but for your initiative, might not have been given to the world for a long time yet, are an offering in the friendly spirit of old, and my best wishes for your future success accompany them.

Towards the close of 1898 a systematic research, carried on for a number of years with the object of perfecting a method of transmission of electrical energy through the natural medium, led me to recognize three important necessities: First, to develop a transmitter of great power; second, to perfect means for individualizing and isolating the energy transmitted; and, third, to ascertain the laws of propagation of currents through the earth and the atmosphere. Various reasons, not the least of which was the help proferred by my friend Leonard E. Curtis and the Colorado Springs Electric Company, determined me to select for my experimental investigations the large plateau, two thousand meters above sea level, in the vicinity of that delightful resort, which I reached late in May, 1899. I had not been there but a few days when I congratulated myself on the happy choice and I began the task, for which I had long trained myself, with a grateful sense and full of inspiring hope. The perfect purity of the air, the unequaled beauty of the sky, the imposing sight of a high mountain range, the quiet and restfulness of the place—all around contributed to make the conditions for scientific observation ideal. To this was added the exhilarating influence of a glorious climate and a singular sharpening of the senses. In those regions the organs undergo perceptible physical changes. The eyes assume an extraordinary limpidity, improving vision; the ears dry out and become more susceptible to sound. Objects can be clearly distinguished there at distances such that I prefer to have them told by someone else, and I have heard—this I can venture to vouch for—the claps of thunder seven and eight hundred kilometers away. I might have done better still, had it not been tedious to wait for the sounds to arrive, in definite intervals, as heralded precisely by an electrical indicating apparatus—nearly an hour before.

In the middle of June, while preparations for other work were going on, I arranged one of my receiving transformers with the view of determining in a novel manner, experimentally, the electric potential of the globe and studying its periodic and casual fluctuations. This formed part of a plan carefully mapped out in advance. A highly sensitive, self-restorative device, controlling a recording instrument, was included in the secondary circuit, while the primary was connected to the ground and an elevated terminal of adjustable capacity. The variations of potential gave rise to electric surgings in the primary; these generated secondary currents, which in turn affected the sensitive device and recorder in proportion to their intensity. The earth was found to be, literally, alive with electrical vibrations, and soon I was deeply absorbed in this interesting investigation. No better opportunities for such observations as I intended to make could be found anywhere. Colorado is a country famous for the natural displays of electric force. In that dry and rarefied atmosphere the sun's rays beat the objects with fierce intensity. I raised steam, to a dangerous pressure, in barrels filled with concentrated salt solution, and the tinfoil coatings of some of my elevated terminals shriveled up in the fiery blaze. An experimental high-tension transformer, carelessly exposed to the rays of the setting sun, had most of its insulating compound melted out and was rendered useless. Aided by the dryness and rarefaction of the air, the water evaporates as in a boiler, and static electricity is developed in abundance. Lightning discharges are, accordingly, very frequent and sometimes of inconceivable violence. On one occasion approximately twelve thousand discharges occurred in two hours, and all in a radius of certainly less than fifty kilometers from the laboratory. Many of them resembled gigantic trees of fire with the trunks up or down. I never saw fire balls, but as a compensation for my disappointment I succeeded later in determining the mode of their formation and producing them artificially.

In the latter part of the same month I noticed several times that my instruments were affected stronger by discharges taking place at great distances than by those near by. This puzzled me very much. What was the cause? A number of observations proved that it could not be due to the differences in the intensity of the individual discharges, and I readily ascertained that the phenomenon was not the result of a varying relation between the periods of my receiving circuits and those of the terrestrial disturbances. One night, as I was walking home with an assistant, meditating over these experiences, I was suddenly staggered by a thought. Years ago, when I wrote a chapter of my lecture before the Franklin Institute and the National Electric Light Association, it had presented itself to me, but I had dismissed it as absurd and impossible. I banished it again. Nevertheless, my instinct was aroused and somehow I felt that I was nearing a great revelation.

It was on the third of July—the date I shall never forget—when I obtained the first decisive experimental evidence of a truth of overwhelming importance for the advancement of humanity. A dense mass of strongly charged clouds gathered in the west and towards the evening a violent storm broke loose which, after spending much of its fury in the mountains, was driven away with great velocity

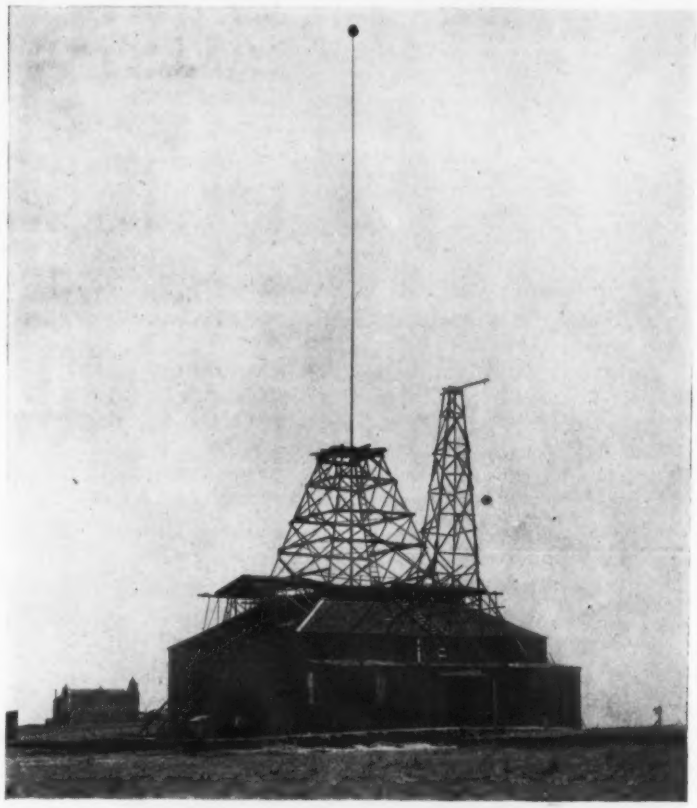


FIG. 1.—TESLA EXPERIMENTAL LABORATORY, COLORADO, ERECTED SUMMER OF 1899.

(Discovery by Mr. Tesla of the Stationary Waves in the Earth was Here Made.)

over the plains. Heavy and long persisting arcs formed almost in regular time intervals. My observations were now greatly facilitated and rendered more accurate by the experiences already gained. I was able to handle my instruments quickly and I was prepared. The recording apparatus being properly adjusted, its indications became fainter and fainter with the increasing distance of the storm, until they ceased altogether. I was watching in eager expectation. Surely enough, in a little while the indications again began, grew stronger and stronger and, after passing through a maximum, gradually decreased and ceased once more. Many times, in regularly recurring intervals, the same actions were repeated until the storm which, as evident from simple computations, was moving with nearly constant speed, had retreated to a distance of about three hundred kilometers. Nor did these strange actions stop then, but continued to manifest themselves with undiminished force. Subsequently, similar observations were also made by my assistant, Mr. Fritz Lowenstein, and shortly afterward several admirable opportunities presented themselves which brought out, still more forcibly, and unmistakably, the true nature of the wonderful phenomenon. No doubt whatever remained: I was observing stationary waves.

As the source of disturbances moved away the receiving circuit came successively upon their nodes and loops. Impossible as it seemed, this planet, despite its vast extent, behaved like a conductor of limited dimensions. The tremendous significance of this fact in

the transmission of energy by my system had already become quite clear to me. Not only was it practicable to send telegraphic messages to any distance without wires, as I recognized long ago, but also to impress upon the entire globe the faint modulations of the human voice, far more still, to transmit power, in unlimited amounts, to any terrestrial distance and almost without any loss.

With these stupendous possibilities in sight, with the experimental evidence before me that their realization was henceforth merely a question of expert knowledge, patience and skill, I attacked vigorously the development of my magnifying transmitter, now, however, not so much with the original intention of producing one of great power, as with the object of learning how to construct the best one. This is, essentially, a circuit of very high self-induction and small resistance which in its arrangement, mode of excitation and action, may be said to be the diametrically opposite of a transmitting circuit typical of telegraphy by Hertzian or electromagnetic radiations. It is difficult to form an adequate idea of the marvelous

FIG. 2.—TESLA CENTRAL POWER PLANT AND TRANSMITTING TOWER FOR WORLD TELEGRAPHY, WARDENCLYFFE, LONG ISLAND, N. Y.

(*Tower is a pyramid having eight sides; smallest dimensions across base, 29 meters; height, 47 meters; total height from ground to top, 57 meters; cupola on top, 20 meters diameter.*)

power of this unique appliance, by the aid of which the globe will be transformed. The electromagnetic radiations being reduced to an insignificant quantity, and proper conditions of resonance maintained, the circuit acts like an immense pendulum, storing indefinitely the energy of the primary exciting impulses and impressing upon the earth and its conducting atmosphere uniform harmonic oscillations of intensities which, as actual tests have shown, may be pushed so far as to surpass those attained in the natural displays of static electricity.

Simultaneously with these endeavors, the means of individualization and isolation were gradually improved. Great importance was attached to this, for it was found that simple tuning was not sufficient to meet the vigorous practical requirements. The fundamental idea of employing a number of distinctive elements, co-operatively associated, for the purpose of isolating energy transmitted, I trace directly to my perusal of Spencer's clear and suggestive exposition of the human nerve mechanism. The influence of this principle on the transmission of intelligence, and electrical energy in general, cannot as yet be estimated, for the art is still in the embryonic stage; but many thousands of simultaneous telegraphic and telephonic messages, through one single conducting channel, natural or artificial, and without serious mutual interference, are certainly practicable, while millions are possible. On the other hand, any desired degree of individualization may be secured by the use of a great number of co-operative elements and arbitrary variation of their distinctive features and order of succession. For obvious reasons, the principle will also be valuable in the extension of the distance of transmission.

Progress though of necessity slow was steady and sure, for the objects aimed at were in a direction of my constant study and exercise. It is, therefore, not astonishing that before the end of 1899 I completed the task undertaken and reached the results which I have announced in my article in the *Century Magazine* of June, 1900, every word of which was carefully weighed.

Much has already been done towards making my system commercially available, in the transmission of energy in small amounts for specific purposes, as well as on an industrial scale. The results attained by me have made my scheme of intelligence transmission, for which the name of "World Telegraphy" has been suggested, easily realizable. It constitutes, I believe, in its principle of operation, means employed and capacities of application, a radical and fruitful departure from what has been done heretofore. I have no doubt that it will prove very efficient in enlightening the masses, particularly in still uncivilized countries and less accessible regions, and that it will add materially to general safety, comfort and convenience, and maintenance of peaceful relations. It involves the employment of a number of plants, all of which are capable of transmitting individualized signals to the uttermost confines of the earth. Each of them will be preferably located near some important center of civilization and the news it receives through any channel will be flashed to all points of the globe. A cheap and simple device, which might be carried in one's pocket may then be set up somewhere on sea or land, and it will record the world's news or such special messages as may be intended for it. Thus the entire earth will be converted into a huge brain, as it were, capable of response in every one of its parts. Since a single plant of but one hundred horse-power can operate hundreds of millions of instruments, the system will have a virtually infinite working capacity, and it must needs immensely facilitate and cheapen the transmission of intelligence.

The first of these central plants would have been already completed had it not been for unforeseen delays which, fortunately, have nothing to do with its purely technical features. But this loss of time, while vexatious, may, after all, prove to be a blessing in disguise. The best design of which I knew has been adopted, and the transmitter will emit a wave complex of a total maximum activity of ten million horse-power, one per cent. of which is amply sufficient to "girdle the globe." This enormous rate of energy delivery, approximately twice that of the combined falls of Niagara, is obtainable only by the use of certain artifices, which I shall make known in due course.

For a large part of the work which I have done so far I am indebted to the noble generosity of Mr. J. Pierpont Morgan, which was all the more welcome and stimulating, as it was extended at a time when those, who have since promised most, were the greatest of doubters. I have also to thank my friend, Stanford White, for much unselfish and valuable assistance. This work is now far advanced, and though the results may be tardy, they are sure to come.

Meanwhile, the transmission of energy on an industrial scale is not being neglected. The Canadian Niagara Power Company have offered me a splendid inducement, and next to achieving success for the sake of the art, it will give me the greatest satisfaction to make their concession financially profitable to them. In this first power plant, which I have been designing since a long time, I propose to distribute ten thousand horse-power under a tension of one hundred million volts, which I am now able to produce and handle with safety.

This energy will be collected all over the globe preferably in small amounts, ranging from a fraction of one to a few horse-power. One of its chief uses will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high-frequency currents and in each instance a terminal a little above the roof will be sufficient. Another valuable application will be the driving of clocks and other such apparatus. These clocks will be exceedingly simple, will require absolutely no attention and

will indicate rigorously correct time. The idea of impressing upon the earth American time is fascinating and very likely to become popular. There are innumerable devices of all kinds which are either now employed or can be supplied, and by operating them in this manner I may be able to offer a great convenience to the whole world with a plant of no more than ten thousand horse-power. The introduction of this system will give opportunities for invention and manufacture such as have never presented themselves before.

Knowing the far-reaching importance of this first attempt and its effect upon future development, I shall proceed slowly and carefully. Experience has taught me not to assign a term to enterprises the consummation of which is not wholly dependent on my own abilities and exertions. But I am hopeful that these great realizations are not far off, and I know that when this first work is completed they will follow with mathematical certitude.

When the great truth accidentally revealed and experimentally confirmed is fully recognized, that this planet, with all its appalling immensity, is to electric currents virtually no more than a small metal ball and that by virtue of this fact many possibilities, each baffling imagination and of incalculable consequence, are rendered absolutely sure of accomplishment; when the first plant is inaugurated and it is shown that a telegraphic message, almost as secret and non-interferable as a thought, can be transmitted to any terrestrial distance, the sound of the human voice, with all its intonations and inflections faithfully and instantly reproduced at any other point of the globe, the energy of a waterfall made available for supplying light, heat or motive power, anywhere—on sea, or land, or high in the air—humanity will be like an antheap stirred up with a stick: See the excitement coming!

The Beginnings of the Incandescent Lamp.

BY THOS. A. EDISON.

IN response to the kind suggestion of the ELECTRICAL WORLD AND ENGINEER that the celebration of its completion of thirty years of existence affords a fitting opportunity to recall the beginnings of the incandescent lamp, I am glad to put on record a brief personal narrative of the details connected with what was to me a very interesting period of electrical development. The occasion is not only a reminder of the rapid flight of time, but of the fact that since 1874—the year of the quadruplex, by the way—all the great modern departments of electrical industry have sprung into vigorous being. We telegraphers have a right to claim this journal also as part of our contribution to the art.

My experiments on carbon began in 1876, when I had the idea of making carbon wire, etc., for various electrical and chemical purposes. Even at that early time Messrs. Charles Batchelor and E. H. Johnson were with me, and we saw quite a business ahead in carbon novelties. I had familiarized myself with the properties of carbon, particularly that made from paper and Bristol board, and this led on very naturally to my work on the carbon telephone or microphonic transmitter, early in 1877. In the fall of that year I was pretty well through with studies and inventions in that line, but had several other ideas that I wanted to work up. One of these was the subdivision of the electric light, and I began experimenting with that purpose. My records and the voluminous testimony in litigation, now happily long past, show that in the fall of 1877, about September, strips of carbonized paper were tried as an incandescent conductor suitable for use in lamps, and the work was followed up until January of 1878, when the general excitement over my invention and exhibition of the phonograph out at old Menlo Park frustrated serious or continuous work for a time, in any other direction. In fact, my health gave way under the strain, and in July I broke away for a Western trip as far as California.

Of course my mind was turning the subject over, and when I got back in August we immediately went at it again. Around October and November Batchelor made a great number of paper carbons, at least 50, from tissue and other kinds of paper, coated over their surface with a mixture of lampblack and tar, rolled up into the fine long form of a knitting needle, and then carbonized. These we put into circuit and brought up to incandescence in vacuo; although they would last but an hour or two. We tried a great many experiments with paper carbons, wood carbons and some made from carbonized broom corn. What we desired at that date, and had settled our minds upon as the only possible solution of the subdivision of the electric light, was that the lamps must have a high resistance and small radiating surface. About December, 1878, I engaged as my mathematician Mr. Francis R. Upton, who had lately studied under Helmholtz, in Germany, and he helped me greatly in calculations of the multiple arc problem. Our figures proved that the lamp must have at least 100 ohms resistance to compete successfully with gas; for if the lamps were of low resistance the cost of the copper main conductors would be so great as to render the system uneconomical and commercially impracticable. In this direction we tried platinum also; and when working on incandescent platinum we had procured a Sprengel mercury pump and had ascertained that we could thus get exceedingly high

FIG. 1.—FIRST PHOTOGRAPH TAKEN BY INCANDESCENT LIGHT.

(*Reproduction of Photograph taken by Mr. Edison at his Menlo Park Laboratory at midnight about Dec. 20, 1879, by the light of three of his first electric lamps. The portrait is that of Mr. Charles Batchelor.*)

vacua. It occurred to me that perhaps a "filament" of carbon could be made to stand in the sealed glass vessels or bulbs, which we were using, exhausted to a high vacuum. Separate lamps were made in this way independent of the air pump, and in October, 1879, we made lamps of paper carbon, and with carbons of common sewing thread, placed in a receiver or bulb made entirely of glass, with the leading-in wires sealed in by fusion. The whole thing was exhausted by the Sprengel pump to nearly one-millionth of an atmosphere. These filaments of carbon, although naturally quite fragile owing to their length and small mass, had a smaller radiating surface and

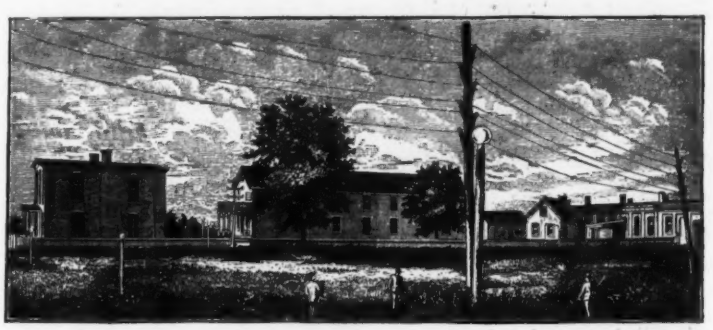


FIG. 2.—VIEW OF EDISON LABORATORY, MENLO PARK, N. J.

(*Showing buildings and outdoor circuits lighted by incandescent lamps, December,* 1879.)

higher resistance than we had dared hope. We had virtually reached the position and condition where the carbons were stable. In other words, the incandescent lamp as we still know it to-day, in essentially all its particulars unchanged, had been born.

We began immediately to make vacuum pumps and to produce these paper filament lamps on them. During that November we made perhaps as many as 100 of such lamps, and the same month saw us plunged deep in experiments and inventions on dynamos, regulators, meters, circuits, etc., all just as necessary to the success of the art as the little lamp itself. Some of those paper filament lamps had a remarkably long life. Each yielded from 12 to 16 cp and they were burned on chandeliers until they gave out. The average life was about 300 hours. One of them lasted 940 hours and another 1,350 hours, so that commercial success and a new industry were already well in sight.

But I was not quite satisfied as to paper, or even with the more regular and homogeneous wood fibre filaments, and thus came to take up bamboo. We happened to have a palm leaf fan on one of the tables. I was then investigating everything with a microscope, so I picked it up and found that it had a rim on the outside, of bamboo, a very long strip cut from the outer edge. We soon had that cut up into blanks and carbonized. On putting these filaments into the lamps we were gratified to see that the lamps were several

times better than any we had succeeded in making before. I soon ascertained why and started a man off for Japan on a bamboo hunt. Before I got through I had tested no fewer than 6,000 vegetable growths, and had ransacked the world for the most suitable bamboo. The use of bamboo was maintained for many years until other processes dealing with such material as cellulose had been perfected. We tried even at the earliest moment of success a number of experiments and things afterwards taken up again or followed through, as for example, burning the paper filaments in a vacuum charged with inert gas; and a little later, in 1880, we also "flashed" the filaments with gasoline vapor.

The furore that followed the announcements from Menlo Park as to the successful subdivision of the electric light in a commercial incandescent lamp will be well remembered by many of the readers of this. The feasibility of such a thing had been denied by some of the greatest minds in electricity, but here it was; and along lines that have endured to this day. The best story at the time was given to the world by the New York *Herald* in December, 1879, and on Christmas Day I had already lighted up my laboratory, my offices, two or three houses about one-fifth of a mile from the dynamo plant and some twenty street lights. On the last day of the year some 3,000 people flocked out to Menlo Park to see it for themselves —and the rest everybody knows.

It is interesting to note that in addition to those mentioned above I had around me other men who ever since have remained active in the field, such as Messrs. Francis Jehl, W. J. Hammer, Martin Force, Ludwig Boehm, not forgetting that good friend and co-worker, the late John Kruesi. They found plenty to do in the various developments of the art, and as I now look back I sometimes wonder how we did so much in so short a time. Early in the spring of 1880 I lighted up for Mr. Villard the Oregon Steam Navigation Company's steamer *Columbia,* and it was not long before the Edison plants began to multiply. Meantime lamp making took on large proportions in two factories of mine, one at old Menlo Park and the other at Newark, and much of my energy was being devoted to cheapening the price of the lamp as well as increasing its life and its candlepower per watt. I am told that upon a moderate computation the production of incandescent lamps in this country since my first success has reached a total of 250,000,000 lamps, or not less than 10,000,000 a year for each of the 25 years. Essentially, the lamp has remained structurally the same ever since 1879, in the elements then demonstrated to be essentially vital and necessary to commercial success.

The Success of Loaded Lines in Telephony.

Upon the announcement of Dr. Pupin's invention, successfully applying self-induction to the improvement of telephone lines, there was much sensational talk in the daily newspapers and elsewhere concerning the use of the invention in telephoning across the Atlantic. The possibilities of such a brilliant project were so attractive that little attention has been given by the public to very important but less sensational applications of Dr. Pupin's work. Accounts of experiments with Pupin coils in Germany and of the successful patent litigation there in their behalf, have been given in these columns from time to time. In this article, we give an account of some of the important steps which have been taken in this country looking to the introduction of the new form of telephone conductor.

Following quickly upon the purchase of the Pupin patent by the Bell interests, overhead lines were loaded from New York to Chicago and to other points in the West. Although a great deal of valuable experimental data has been obtained, the extension of the loading of overhead lines has not been continued. Unforeseen difficulties in the nature of cross-talk and leakage effects were encountered, and while they are not sufficient to prevent ultimately the extension of the system to overhead lines, they have called attention to a number of features in line construction which must be attended to before complete success in overhead loading is attained. A vast amount of work in overcoming these temporary difficulties has already been done, and although many points still require investigation, it is safe to say that this phase of the problem presents no difficulties which are insuperable and which cannot be expected to yield to patient and intelligent research.

In the loading of underground cables, a great deal of important and successful work has been accomplished, particularly in the neighborhood of New York City. From Cortlandt Street to Newark, N. J., a distance of about ten miles, there are working successfully 50 pairs in No. 19 B. & S. gauge cable, equipped with Pupin coils. Each of these circuits when loaded gives a talking equal to that which would be obtained through six miles of the No. 19 gauge cable unloaded. These 50 pairs have been in satisfactory service since August, 1902. From Cortlandt Street to Elizabeth, N. J., a distance of seventeen miles, 50 pairs of No. 19 gauge conductors are also equipped with Pupin coils, and are giving satisfaction. The talk obtained over these seventeen miles of loaded cable is equal to that which would be obtained through about seven miles of the same kind of cable unloaded. From the central office in Brooklyn to Far Rockaway, Long Island, there is a cable of No. 19 gauge, partly underground and partly overhead. This cable is about eighteen miles long, and talks as well when equipped with Pupin coils as would eight miles of standard cable of No. 19 gauge operated without coils. From the Brooklyn central office to Jamaica, L. I., there is a standard cable of No. 19 gauge, twelve miles long, provided with Pupin coils. This cable talks as well when equipped with the coils as would six miles of the same kind of cable without the coils. From Cortlandt Street to Fordham, in the Borough of the Bronx, a distance of fourteen miles, there are fifty pairs of conductors of No. 16 B. & S. gauge equipped with Pupin coils. The talk through these fourteen miles of No. 16 gauge cable equipped with coils is as good as that which is obtainable through four and a half miles of No. 19 gauge standard cable without coils. From Cortlandt Street to Kingsbridge, in the Borough of the Bronx, a distance of fifteen miles, there are 50 pairs of No. 13 B. & S. gauge conductors in an underground cable equipped with Pupin coils. The talk through these fifteen miles of cable thus equipped with coils is equal to that which would be obtained through three miles of standard No. 19 gauge cable without coils. In all of these cases the conductors are being used satisfactorily for commercial business, and the results obtained are a splendid practical demonstration of the value of Dr. Pupin's theoretical work.

Although ocean telephony is not yet an accomplished fact, the application of loading to suburban trunk lines in the neighborhood of large cities has already proved to be of very great importance. All of the electrical principles involved in the problem of ocean telephony apply to that of underground land lines, and the fact that in those lines such successful results have been obtained has led some of our prominent engineers to express themselves most hopefully with reference to the ocean telephone cable.

Prior to the work of Dr. Pupin, there was no generally recognized method of overcoming the electrical difficulties presented by the problems of ocean telephony. Prof. Pupin has shown how to overcome these electrical difficulties. As the problem now stands, it is mainly a mechanical one, and consists in incorporating into an ocean cable at suitable intervals coils of iron and copper having the proper inductance. Looking at the problem broadly, it seems safe to say that greater mechanical difficulties than this have been overcome and that there is good reason to hope that during the life of the Pupin patent, we may witness the operation of a high speed ocean cable which would permit not only of the transmission of speech, but what would probably be more important, the successful use of high speed telegraphy across the Atlantic.

The effect of the Pupin invention upon long distance land lines is one which has been the subject of much debate. While there is no doubt that the art of loading has already greatly extended the effective range of underground telephone cables, it is a great mistake to assume that with the Pupin invention, the universal placing underground of telephone trunk lines is practicable. At the present time and for many years to come, the most important function of the invention will be to provide suitable underground circuits for the suburban trunk lines in the neighborhood of our great cities and to permit of "long distance" wires being placed underground for short distances within the great cities.

Notwithstanding the Pupin invention, the most practicable way of operating such long distance lines as that from New York to Chicago is to carry them overhead, except for short sections of loaded cable at each end. If it were attempted to place such lines underground throughout their entire length or even in the various intermediate towns and villages which they travers, the economies of long distance telephony would disappear and the public would be deprived of a most valuable adjunct to its commercial enterprise.

To the use of subscribers' lines extending to the central office the Pupin invention has no practical application. These lines are usually but a mile or two in length, and do not permit of being economically loaded.

The Development of Industrial Electrochemistry.

BY DR. E. F. ROEBER.

WHILE of all branches of electrical engineering electrochemistry has been the last one to achieve commercial successes on a large scale and may justly be considered to be still in the first phase of its industrial development, yet its fundamental principles were long exactly known (electrolytic action-Faraday's law, electrothermic action-Joulean heat). Moreover, at the beginning of the nineteenth century the very first experimental applications of the newly discovered electric current were of an electrochemical nature. Shortly after the primary battery had been invented by Volta, Nicholson and Carlisle succeeded in decomposing water by electrolysis, and in 1807 Sir Humphry Davy delivered his famous lecture on some chemical agencies of electricity. Yet (to quote from the recent Bradley patent decision) "Davy's experiments were permitted to lie dormant during seventy-six years of intense activity," and in general the progress in the development of industrial electrochemistry and electrometallurgy was extremely slow for a long period. In fact, thirty years ago, when the first issue of this journal appeared, there did not exist any electrochemical industries, with the single exceptions of electroplating and primary battery manufacture.

It is now not difficult to see what held the development of industrial electrochemistry back. In nearly all electrochemical and electrometallurgical processes the cost of the electric power is a large fraction of the total cost of operation, often 25 per cent. or more, and even up to 90 per cent. Cheap electric power is, therefore, the fundamental requirement for the economical working of an electrochemical process, in exactly the same way as it is for electric lighting, traction and power purposes in general. Before the advent of the dynamo, the primary battery was the only available source of the electric current, if we except a limited use of the thermo-pile, and its limitations are obvious. The operation of a primary cell meant and still means essentially oxidation of zinc. When zinc changes from the metallic state into bivalent ions, 1.22 grams are oxidized, according to Faraday's law, for every ampere-hour; we know that, with all possible combinations of zinc with other materials in a primary battery, we never get much more than 2 volts, and if we assume the useful e.m.f. to be 1 volt (which is very fair for such an estimate), then every kilowatt-hour produced means the oxidation of 1.22 kg (or 2¾ pounds) of zinc. This is the theoretical value which really represents a minimum of actual consumption; moreover, it does not include the cost of the other materials in the cell, nor the cost of construction and attendance; but it is sufficient to indicate the inherent limitations of the zinc primary battery.

So long as primary cells were the only commercial sources of electric current, the applications of electrical engineering were thus necessarily restricted to those cases in which a very small amount of power only is required. That is especially the case in telegraphy, and, in the field of electrochemistry in those cases of electroplating in which a soluble anode is used of the same metal which is to be deposited upon the cathode. Here the voltage required at the terminals of the plating bath is consumed in overcoming the internal resistance only, which may be made small, and, therefore, the power may also be insignificant.

It is quite natural that after the dynamo had made its commercial appearance, electric lighting and the mechanical applications of electricity, such as traction and power transmission and distribution, first attracted the inventive talents of electrical engineers. Nevertheless, as we were reminded by the recent Institute dinner to Mr. Edison, the incandescent lamp is now only 25 years old. It is, therefore, not surprising that our electrochemical industries are still young, since their development depended rather on chemists and metallurgists, who were attracted by the possibilities of the application of the electric current which had proven to be such a manageable and thoroughly reliable agent in other fields of engineering.

The following sketch naturally does not aim at completeness, and no attempt will be made to give details of processes. The object is rather to bring out some general principles which have manifested themselves all along during the development of the electrochemical industries—Leitmotives, to borrow a word from Wagner's operas. At the same time, we will try to arrive at a convenient classification of the whole subject. One general subdivision of all electrochemical processes and phenomena into two large classes offers itself. In the first class electrical energy is consumed to produce chemical effects, while in the second class chemical energy is changed into electrical energy. Thus, the second class comprises the whole field of primary cells and storage batteries, while in the first class we have all those more or less novel processes which are now mostly thought of when one speaks simply of electrochemical and electrometallurgical industries.

Chemical effects may be produced by means of electrical energy in various ways. We can change the electrical energy into heat, which is then consumed in producing the desired chemical effect; or we can change electrical energy into chemical energy directly by electrolysis; or we may use a combination of both methods; finally, a fourth method of producing chemical effects is by passing an electric discharge through gases. Before giving a cursory review of applications of these various principles, a general remark should be made on the nature of chemicals produced by such methods.

Many of these processes consume a considerable amount of electrical energy. In the discussion of furnace processes from the ordinary chemical point of view, we may, of course, say that the energy is expended to produce a certain temperature which is required to start the process. This, however, does not tell the whole story. We expend a certain amount of electrical energy which is lost while the process is going on. What becomes of it? If the process is conducted under fairly economical conditions most of the electrical energy is changed into chemical energy and is stored up in this form in the chemicals produced.

In other words, if an electrochemical process requires the expense of an appreciable amount of electrical energy, then the products of the process possess a higher content of chemical energy than the starting materials. This explains why electrochemical methods give us substances of strong chemical affinity. Moreover, these substances represent in a sense a storage of energy, which at the same time enables one to ship readily the stored energy to a point where it may be wanted. Two examples may explain this.

Aluminum does not occur free in nature and its separation from its compounds requires a considerable amount of energy. If we electrolyze aluminum oxide dissolved in a bath of fluorides, we get aluminum and oxygen; the formation heat of Al_2O_3 is 392,600 calories; hence, according to Thomson's rule (which is fully good enough for this purpose) we must apply at least 2.8 volts at the terminals of the cell. This voltage, multiplied by the coulombs passed through the cell, represents the electrical energy which is changed into chemical energy. That is what Hall does in producing aluminum in his cell. Now, we may ship the aluminum somewhere and may then allow it to combine again with oxygen to form back Al_2O_3. Then we get back our energy in the form of most intense heat. This is what Goldschmidt does in his thermit process. (Of course, he loses the energy which is required to reduce the iron oxide in the thermit; but this is small, compared with the formation heat of Al_2O_3.)

In the Union Carbide Works in Niagara the energy of the Falls, after conversion into electrical energy, is stored in form of chemical energy in calcium carbide. As long as we keep it separate from water, the calcium carbide represents a storage of a distinct amount of energy. We can afterwards use it for the production of energy by generating acetylene from the carbide and water and using the acetylene for lighting; and we may do this anywhere, since the carbide can be easily shipped.

These two examples, while simply given to illustrate the energy point of view, are also suggestive as to what we may expect from future electrochemical developments. The achievements of the past have given us new methods of storing and transmitting energy; they have enormously cheapened the production of known substances, like aluminum, and have given us new substances of great commercial usefulness.

In this respect the industrial development of the electric furnace is very instructive. As the pioneers of electric furnace work, the two brothers, Eugene H. Cowles and Alfred H. Cowles, have highly distinguished themselves, especially in the production of aluminum alloys. For the industrial development of the resistance furnace, the highest credit is due to the persevering work of Edward Goodrich Acheson. The extended laboratory researches of the French professor, Moissan, have thrown much light on the production of carbides.

The distinction between arc and resistance furnaces is so familiar that it is unnecessary to dwell on it here, nor shall details of design be discussed. But we may record the gradual change of the purpose to which the electric furnace is being put in practice. In the early

days the intention was to produce as high a temperature as possible, and the result was the foundation of entirely new industries, like those of calcium carbide, carborundum and artificial graphite. For the production of these substances temperatures were required that could not be obtained by any other means but the electric furnace. In more recent years the intention has been rather to design furnaces so as to allow exact regulation of the temperature, and the electric furnace has thus been found suitable for reactions which do not require abnormally high temperatures.

The effect of regulating exactly the furnace temperature is very instructively shown by the example of treating a mixture of silica and carbon, which has been one of Acheson's fields of special research. By changing the conditions (by an appropriate design of the furnace so as to meet the special conditions of each case) it is possible to produce any one of the following substances: Carborundum, "white stuff," graphite, silicon, siloxicon.

The abnormal boom of calcium carbide in Europe, which naturally led to overproduction, resulted in various European furnace plants, originally erected for carbide, becoming free for other purposes. In looking for new processes it seems that nothing has more attracted the interest of European electrometallurgists than the possibilities in the electrometallurgy of iron and steel. Actual success has been achieved in the production of special steels (tool steels, crucible steel). A very great variety of arc and resistance furnaces have been developed for this purpose and in all of them care is taken to prevent contaminations of the bath from the carbon electrodes. Of special interest in connection with this latter point is the use of a resistance furnace, based on the induction principle, the fused steel forming the single secondary turn of a transformer, no electrodes whatever being used in this case.

While the above processes are all purely electrothermic, the most notable example of a combination of an electrothermic with an electrolytic process is the manufacture of aluminum. The electrolyte from which the aluminum is deposited is a solution of alumina in a bath of fluorides, and its discovery which made the manufacture of the cheap aluminum of to-day possible is due to Charles M. Hall in this country and to P. L. T. Héroult abroad; both arrived independently of each other at the same solution. By a recent court decision the electrothermic side of the process was held to be covered by the internal heating patent of Charles S. Bradley. What the electrochemical method of manufacture has done for aluminum is perhaps best indicated by the fact that the price of one kilogram was $250 in 1855, against 50 cents now. The Pittsburg Reduction Company has now something like 22,000 hp in operation for the production of aluminum, and it is evident that the greatest efforts are to be made to push the use of aluminum for all possible purposes.

Other examples of a combined electrolytic and electrothermic reaction are the production of metallic sodium by the Castner process of electrolyzing fused caustic soda, and the Acker process of producing caustic and chlorine by electrolyzing fused sodium chloride with a cathode of molten lead.

While the Acker process is the latest and one of the most carefully developed processes for the electrolytic production of caustic and bleaching powder, it is by no means the only one, since there is an abundance of processes in which an aqueous solution of sodium chloride is electrolyzed. We thus come to the class of purely electrolytic processes. Of course, Joulean heat and a certain electrothermic effect is here not absent, simply because it is impossible to avoid it. But it is generally so small as to be neglected, and, in fact, there are many cases in which it is necessary to make it small, since the output would be decreased by increased temperature.

One preliminary remark may be made on electrolytic processes in general. An electrolytic cell represents an electrochemical system and it is mostly possible to arrange it in such a way that when electrolysis begins we get the products which we want. But when electrolysis is continued we have no longer our original electrochemical system and the products of electrolysis may no longer be pure; we may now get something we do not want. The first condition that must be fulfilled for the successful working of an electrolytic process on an industrial scale is to have the conditions good at the start, to begin with pure solutions and to maintain them pure during electrolysis. As F. Haber says, everything can be accomplished with pure solutions; nothing with foul solutions. In many cases in which a process looked promising from the experiments made on a small scale in the laboratory, it turned out to be afterwards a failure on a large scale, because the electrolyte soon became impure and its purification required expense and the overcoming of difficulties which had not been expected in advance. The same fundamental principle of the working of electrochemical processes is expressed by D. H. Browne in a slightly more general form when he asserts that the keynote of success in electrolysis is to keep initially good conditions permanently good. Close experiment will almost always reveal the proper conditions under which certain work can be done, but the continuance of these conditions is attainable only by continual vigilance.

To return to the electrolysis of an aqueous solution of sodium chloride, the products of electrolysis are caustic soda and hydrogen at the cathode and chlorine at the anode. This is what is wanted if our final products are to be bleaching powder and caustic. But if we did not remove the caustic soda and chlorine from our cell we would have a new electrochemical system. The catholyte would then be a mixture of caustic soda and sodium chloride and the ions of caustic soda would participate in the conduction of the current and hydroxyl ions would travel towards the anode and produce new reactions. New reactions of a secondary nature would also be started by the mixing of the chlorine and caustic in the solution, due to diffusion and convection currents. It is thus clear that since our electrochemical system has changed we get new products which we do not want. The technical problem is, therefore, to keep the anodic and cathodic products of electrolysis separate from each other. It has been solved in three essentially different ways.

The first is to separate both compartments mechanically by a diaphragm. As an early pioneer of diaphragm processes, E. A. Le Sueur has been active in this country. The largest American plant using a diaphragm process (that of the Dow Chemical Company) is situated in Midland, Mich., while various diaphragm processes are in successful use in numerous paper and pulp mills, notably in New England.

The second general method is to keep the anodic and cathodic liquids separate from each other by making use of their different specific gravities (Glockenprocess, gravity process). This method is especially interesting as one of the comparatively few cases in which scientific research (in this case the determination of the transport numbers of the ions) has finally led to a new industrial process. While this process is in successful operation abroad, it has not yet been introduced into this country.

The third general method is to eliminate the sodium ions which are discharged at the cathode by alloying them with the mercury cathode. This process in the form developed by Hamilton Young Castner and C. Kellner is in use on a large scale in Niagara Falls. The elimination of the sodium from the cell by alloying it with a fused lead cathode in the Acker process is, of course, quite analogous.

In the manufacture of caustic soda and bleaching powder by electrolysis of sodium chloride, the electrolytic methods, sketched above, had to compete with one of the most firmly established chemical industries. The outcome of the war between the old chemical and the new electrochemical methods has been a victory for the latter, although the financial returns have been comparatively small, on account of the demoralization of the market.

While in the production of caustic and chlorine the purpose is to separate and maintain separated the anodic and cathodic products, just the reverse is the case when we want to obtain bleaching liquors or hypochlorites, since they are produced by a reaction between the chlorine and caustic. For this purpose it is evidently necessary to have the electrodes near together and to aid the above reaction by stirring. Several forms of hypochlorite apparatus are in use abroad, but have not yet found any extended use in this country. By modifying the conditions of operation, it is possible to produce chlorate, the main points being the use of a moderately high temperature and precautions for preventing reduction. This example shows how completely the results of a reaction may be changed, by varying the conditions, and it emphasizes the necessity, pointed out above, of carefully maintaining the original conditions of the system unchanged during electrolysis, if we invariably want to get the same results.

In electroplating, the problem is to have always a sufficient number of the metallic ions to be deposited, in close proximity to the cathode. The tendency of the current is to impoverish the solution near the cathode. This tendency must be counteracted. Stirring the solution and revolving the electrodes are suitable means and care must be taken to obtain proper corrosion of the anode which has to supply new metallic ions to replace those deposited at the cathode. There

are now more than 1,200 electroplating establishments in the United States and in recent years a tendency has manifested itself to give up the old rule-of-thumb methods and to work according to exact principles.

Of much greater industrial importance, however, is the kindred art of electrorefining. In 1879 an experimental copper refining plant was in operation for a short time at Phoenixville, Pa., but the first commercial copper refining in America was erected in the early 80's. This is the Balbach works in Newark. To-day there are in operation in this country ten electrolysis refineries with a total daily copper output of 764 tons, or 279,000 tons per year. At the same time 27,000,000 ounces of silver and 346,020 ounces of gold are recovered per year in these refineries. (Ulke.)

There is a very peculiar difference in the details of operation of the different refineries. Two plants use the series arrangement of electrodes, all others the multiple system. There is a considerable difference in the current density used; of two plants in the West, in close proximity, one uses 40, the other 12 amperes per square foot. The list of variations in the method of operation could be easily enlarged. In other words, the art of copper refining is far from being standardized. Since it is known that for a number of years the different refineries have very carefully and systematically studied the best conditions of operation in their own case, the difference in the methods of the different refineries may be attributed to a difference in the given conditions in each case. If this is so it emphasizes the complexity of the economical working of even so simple an electrolytic problem as copper refining.

Recently the Betts process of lead refining has aroused very great interest. The essential point is the electrolyte, which is a solution of lead fluosilicate, containing an excess of fluosilicic acid. It is easily prepared from inexpensive materials, it conducts the current well and it dissolves other metals but lead only in very small quantities. The last point is of great importance in view of the fundamental requirement that the solution should remain pure during operation. In a similar way, for copper refining the possibility of continually renewing the electrolyte is essential.

The Wohlwill process of gold refining is in operation at the Philadelphia Mint, using an electrolyte of gold chloride, rather strongly impregnated with free hydrochloric acid. The addition of the free hydrochloric acid in this case, like that of fluosilicic acid in the Betts process, is necessary to produce the proper corrosion of the anode and to maintain the electrolyte in its original condition. Much special study has been devoted in recent years to the question under what conditions dense solid cathodic deposits of metals are obtained. The simple method by which, in the case of lead, Betts overcomes all difficulties in this respect—by providing a reducing action, practically accomplished by the addition of gelatine or glue—seems very encouraging.

As the reverse case of electroplating, we may consider the electrolytic stripping of metals. The production of tin from tin scrap has achieved considerable commercial success, first in several plants in Germany, from where it was recently imported to this country. An interesting similar process, although of much less industrial importance, is the method of Burgess, which was used in bicycle manufacturing works for removing the thin layer of brass on the surface of the frames by electrolysis, with a sodium nitrate solution as electrolyte. This example is mentioned to show how electrochemical methods may be applied to details in various manufacturing processes and may effect an important economy of labor.

In their application to the metallurgy of gold, the use of electrolytic methods has been confined to the cyanide process, as far as commercial success has been obtained. Electrolytic precipitation has been used successfully in the Siemens & Halske process in South Africa, although side by side with zinc precipitation. The latter method is nearly exclusively used in this country. But it should not be overlooked that the latter method is also essentially an electrochemical phenomenon. Chemically pure zinc is inactive as a precipitating agent. What is needed is commercial zinc containing small particles of impurities, or specially prepared zinc couples, like zinc-lead. Thus, while with electrolytic precipitation we have the source of the electric current outside of the precipitating vat, we have with zinc precipitation an immense number of small short-circuited galvanic couples in the precipitating vat itself.

In the production of metals from ores, much research has been devoted to the problem of getting copper and nickel from the Sudbury ores. The late Dr. Hoepfner did highly valuable pioneer work in this line, but full commercial success was obtained by David H. Browne, who, in working out his process in which chlorine passes through an ingenious cycle, paid proper attention to the fundamental requirement that pure solutions must be provided and maintained.

An interesting and novel electrometallurgical process which, however, has not yet attained industrial importance, is Salom's reduction of lead from galena by direct cathodic reduction.

That class of processes in which chemical effects are produced by discharges through gases is the youngest in the development of industrial electrochemistry. Commercial success has been achieved abroad with the production of ozone from air and the subsequent use of ozone for sterilizing water. If the cost is not prohibitive, there should be a commercial future for such processes in this country. Great interest has been aroused by the Bradley-Lovejoy process for the fixation of nitrogen from the air. The process is still in its experimental stage and a successful issue would have a revolutionary effect in many branches, particularly in agricultural chemistry. The variety of possible methods is indicated by the utilization of the silent discharge in ozonizers, while Bradley and Lovejoy produce arcs, but so finely subdivided as to give a large surface for small energy.

This cursory review does not nearly exhaust the subject of producing chemical effects by electrical means, but it is hoped that it gives at least a general idea of the achievements of the past and of the possibilities of the future, together with some general principles which should always be kept in mind in connection with this subject. We may be permitted to treat even more briefly the reverse problem, that of producing electrical from chemical energy.

There is not much to be said concerning primary batteries. Their limitations, if zinc is used as "fuel," have been pointed out above. The problem has, therefore, been to substitute carbon for zinc and to devise a "carbon cell." The effect would be commercially far-reaching. At present we burn the coal in connection with boilers, steam engines and dynamos and thus produce electrical energy by a roundabout method, with a low efficiency, since the efficiency of the steam engine is limited by the principles of thermodynamics. There would be no such limitations with a carbon cell. But the trouble is that such a cell is still a dream. Theorists and "practical men" have attempted the solution of the problem, but have equally failed.

On the other hand, storage battery engineering has passed with success through an extremely active career and the outlook is bright for the future. As early as 1856 Gaston Planté began his extended investigations on the formation of the lead accumulator. His method was purely electrochemical. Starting with metallic lead sheets, he submitted them to the action of the electric current in dilute sulphuric acid. But since the cell had to be charged and discharged a great many times, his method of formation required a very long time and was expensive. The technical problem was, therefore, to shorten the time of formation.

Faure abroad, and Brush in this country, devised in the early 80's an improvement of the Planté cell, which consisted in mechanically applying active material to a conducting support. They thus produced instantly a plate, the manufacture of which by the Planté process, would have required several months. Immediately afterwards an extreme activity began in storage battery invention, the goal being to avoid the claims of the Brush patent. The outcome was a modification of the original electrochemical Planté formation by replacing the electrolyte of pure dilute sulphuric acid by an oxidizing electrolyte. Moreover, purely chemical formation without any current was also found practical.

Along these general lines the successful lead battery of to-day was developed. The number of United States patents on this subject is legion, but the patents generally refer either to details of construction or to composition of the electrolyte for formation. Storage batteries have found very extended use in direct-current central stations and sub-stations. In fact, stationary batteries for such work represent at present 75 per cent. of all the storage batteries manufactured, and for this purpose the position of the lead cell seems secure.

In recent years, however, the possibilities of electric automobilism have encouraged inventors to search for a battery of light weight and small size. The use of lead was considered as essentially unsuitable for this purpose. The researches were mostly made along the lines of alkaline batteries. Finally the aim was the design

of an "oxygen lift" cell, with potassium or sodium hydroxide as electrolyte and electrodes simply undergoing oxidation and reduction and insoluble in the electrolyte in all states of oxidation. Several inventors have worked along this line, among them Jungner. But commercial success was first attained by Thomas A. Edison with his nickel-iron battery, which, it seems, will have a field of its own, especially for automobile work.

A Quarter Century of Electric Lighting.

By Dr. Louis Bell.

THE growth of a new art is a startling phenomenon. The familiar manufacturing enterprise of a nation may, under normal conditions, be expected to keep pace with the growth of the population in numbers and in wealth and save for commercial disaster now and then, or for artificial stimulus by governmental action, to move forward at a fairly regular rate. But the irruption of a new art like electric lighting is a very different matter. It grows in response to a law of demand that bears no definite relation to anything and while, of course, this growth is affected by local causes and by the conditions of general prosperity, it depends largely upon intrinsic factors in the art itself, the effect of which cannot be predicted, but becomes visible in the fullness of time.

One may study the phenomena of such growth as a pure matter of statistics, but while such an examination may, like other statistics correctly show effects, it fails utterly, as statistics usually do, in showing the causes which produce them. Cause and effect can be correlated, but only by studying the circumstances which are concurrent with the figures. The relations between figures and facts are far too complicated to be self-evident.

Starting then with the broad facts that less than twenty-five years ago incandescent lighting by central stations began, and that to-day the whole business occupies nearly 3,700 stations, represents an investment of more than half a billion dollars, and draws a gross yearly income of nearly ninety million dollars, it is worth the while to attempt to trace the reasons for so prodigious a growth and the factors which have gone to produce it.

In that quarter century the population of the country has increased about 80 per cent., and few large industries have greatly exceeded this rate of growth; but electric lighting starting from absolute non-existence has risen to an industry of the first rank in the face of strong competition from other illuminants, and what is more, in the face of a cost which throughout its whole early history was undeniably higher than that of any other illuminant. It has made its way through the operation of favoring factors other than economy, ranking as a luxury rather than a necessity, and only within a few years being able to meet competition on the simple basis of cost. These facts are very unusual in the history of a great industry and deserve careful consideration. They are the more extraordinary when one considers that for some years electric lighting was not only upon the whole the most costly but the least reliable form of illumination, was fought viciously by the fire underwriters, suffered from ferocious internecine strife among its exponents and had been a very Gettysburg of patent litigation.

When late in 1879 the incandescent lamp appeared as a commercial possibility, the arc lamp had already been for some years in slowly increasing use both here and abroad, mostly for small private installations, for the quite sufficient reason that the largest arc dynamos would handle but a few lamps, not enough to cut any figure at all for anything but the smallest plants. Nevertheless it was perfectly evident that the arc had come to stay. It had the inestimable property of giving white light in the form of a very intense and powerful unit. Before the electric arc came into use, lights of similar power were practically non-existent, and the arcs could therefore give a brilliancy of effect previously unknown. This fact of itself accounted for their rapid growth in popularity and when their accurate rendition of color values is taken into account it is small wonder that they made a sensation. The Jablochkoff candle, practically the earliest commercial form of arc, was, in spite of its limitations, altogether remarkable in the quality of the illumination given, and, in fact, would be difficult to surpass in this particular. It is interesting to note that it has continued in limited use even up to the present time.

The arc lamp therefore did the pioneering for the incandescent lamp. It educated the public to the appreciation of the importance of color values in illumination, drew once for all a line between weak illuminants and powerful ones, and caused all eyes to be turned to electricity as the coming source of illumination.

Then came the incandescent lamp in response to the demand for smaller electric lights. The subdivision of the electric light was the problem of the day, and very fortunately this problem was solved by the glow lamp instead of by arcs of small candle power, which could not then have been, and, in fact, never since have been, satisfactory illuminants. The incandescent lamp nearly equalled the arc in rendering color values, and enormously surpassed it in convenience and steadiness.

It was far less economical than the arc and was not for some time on public circuits able to compete with gas, but it made its way by reason of its better color, its steadiness and its freedom from vibration of the air, and from overheating. These good qualities carried it ahead in spite of all opposition. It is hard to realize to-day how much these gains meant in interior illumination, but they were fully realized at the time and they unquestionably won the day for electric lighting. Looking over some ancient history recently the writer came across a printed letter reporting results from one of the early isolated plants, that in the Pemberton Mills, installed in October, 1881. Although in this case two 4 ft. gas jets were replaced by each "A" lamp of 16 alleged candle power, a great improvement was noted in the conditions of illuminations, especially with regard to color vision in work on colored fabrics, and in the purity of the atmosphere. Further, it was shown that the cost of the electric light, including interest and depreciation at 12 per cent. and lamp renewals at a dollar apiece, was less than the cost of the gas for the burners replaced by more than a half.

One smiles nowadays at the idea of replacing two 4 ft. gas jets by one 16-cp lamp, but the fact of doing so was a valuable lesson in illumination, proof that a steady light, good in color, can actually with positive advantage replace lights of greater gross intensity, but lacking these two things.

A good many people who ought to know better have not learned this lesson yet and still foster the idea that illumination intrinsically bad can be made good merely by increasing its quantity.

The incandescent lamp practically won its way through quality, for only under rare conditions could it at first show economy over gas at the prices generally current. Once introduced and appreciated it was rapidly pushed ahead. It was a thing to advertise in one's business and to brag about to one's neighbors, and its use thus spread with the added momentum due to fashion. With it came increased use of arc lamps, partly in competition, but still consistently backing up the public demand for bright light and more of it. Pretty bad some of those early arcs were, too, but they did what gas never had done—they really lighted large areas effectively by dint of sheer brilliancy. Between the arcs and incandescents there was awakened a demand for public electrical supply, though, by a strange freak of fate, the arc and the incandescent systems, beautifully fitted to supplement each other's work, fought like cat and dog, damning each other with an ingenuity of objurgation that would be worthy of a unique position in profane history. Apparently this mutual abuse served simply to make violent partisans, and both systems flourished. Forward steps were rapid, and on the one hand arc machines carrying a respectably large series of lamps soon came into use, and the carbons, at first horribly bad, were so improved as greatly to better the steadiness of the light. On the other hand, the incandescent lamps were greatly improved in manufacture so that their useful life was largely increased, the bamboo filament was fashioned into as good practical working form as its nature permitted, and the invaluable three-wire distribution was brought into wide use. In large cities incandescent lighting was giving good account of itself in competition with gas, but it was not yet able on account of the inherent limitations of a low pressure distribution to work advantageously in the smaller places where absence of competition from gas would give it an advantage. At the present time more than three-quarters of the central stations are in such places and have the field to themselves.

Desperate efforts were made, with indifferent success, to build up an incandescent lighting business on arc circuits. Such lights have never been wholly satisfactory even for street lighting, and the danger of high potential wires kept them for the most part

out of buildings. The greatest impetus that the art of electric lighting received after the invention of the incandescent lamp was the introduction of the alternating-current transformer system in 1885, when the first plant went into operation in Great Barrington, Mass. The next two years saw the system put into practical shape, and thereafter the growth of small stations was startlingly rapid. The number of new plants started in 1885 was but 55, the next year it was 100, the next 147, the next 160, and in 1889 it arose to 208. A large part of this activity was represented by small alternating-current plants. Bad as they were from our modern standpoint, their old 50-volt lamps did good service, for they were far easier to turn out successfully than the more delicate 110-volt lamps of the direct-current system. It is interesting to note that in some of the very earliest Edison plants 8 and 10-cp lamps were freely used, but difficulties of manufacture and the customary gas standard of 16-cp soon forced the small lamps out of use only to reappear years later.

Meanwhile, arc lighting had prospered, machines capable of operating forty lights or so in series had come into use; the lamps were of far better quality than before; and, reinforced by the power of working an incandescent system with alternators, the old arc stations took on a new activity. With the alternating system, too, came alone by stress of competition, various improvements in incandescent lamps, including the flashing process now universally used, and Mr. Weston's structureless cellulose filament, now, after various modifications, in universal use. These improvements are the basis of scientific lamp manufacture, and the fierce fight that was waged between the natural and artificial filaments now seems a curiout bit of ancient history. The first ten years of central-station lighting, with their ferocious strife of "systems" were years of tremendous progress, and desperate competition, often unwise and injurious, but serving to keep the art moving forward and strengthened its hold upon the public.

Fortunately, the one great improvement in gas lighting, the introduction of the incandescent burner, had not yet come to active service, else electric lighting would have had a far harder struggle for existence than it actually found. And when the incandescent burner actually did come into competition with electric lighting, its life was so uncertain and its color so vile that it made small headway until electric lighting was in better shape for hard fighting. Even now, in spite of repeated alleged improvements, the color of the incandescent gas lamps is ordinarily so bad as to put them at a hopeless disadvantage.

But better things were in store for electric lighting. The war of "systems" drew to a close by the crippling of some combatants and honorable truce among others. The electric railway had come to strengthen the hands of the electrical industries in general, and the troublesome problems of alternating-current distribution, of proper insulation for machinery and for lines, and of machine design, were being rapidly threshed out. There is no absolute dividing line between the old and the new, but about 1890 electric lighting took a firmer hold and began the period of its most effective growth.

The period was not signalized so much by brilliant discovery as by the application of sound common sense. The first step of importance was the introduction of large dynamos, generally direct-coupled. Although direct-coupling had been tried by Edison in the very beginning of central station work, dynamo design was not then far enough advanced to ensure success, but these later direct-coupled units revolutionized the central station business, simplifying problems of distribution, improving regulation, increasing station efficiency, and generally putting incandescent electric lighting on an economical and business-like basis. Arc lighting, too, was proceeding on broader lines with larger units, and presently came the successful constant potential arc, putting it in the power of the incandescent lighting station to do all classes of business over the one network. This unification was perhaps the most important step that has been taken in central station practice, and it immediately gave electric lighting an economic lift that was very quickly felt. It became possible to put prices at a point that attracted business, and in the early nineties not only was building active, but there was an extensive course of rebuilding and change of equipment which really inaugurated the modern period of electric lighting.

About ten years ago the idea of unification of service was extended to alternating-current practice by the introduction of polyphase apparatus. The first applications were to power transmission plants, which did not in themselves affect the lighting industry very greatly; but a little later the very extensive adoption of polyphase transmission in central station working via sub-stations rose to great importance in increasing the facilities of the large urban plants. At the present time more than 60 per cent. of the total dynamo capacity in the central stations of the country is in the form of polyphase and other alternating-current generators. The introduction of these big modern alternators has enabled conditions of good regulation to be maintained on alternating-current distribution systems, and has, by improving the service, greatly stimulated incandescent lighting on such systems. The substitution of large transformers feeding secondary mains for the house-to-house distribution has also had a most important effect in improving business and in increasing station economy so as to give more encouraging financial returns.

Arc lighting was much less stimulated by these changes than was incandescent lighting, for the alternating arc has never obtained a firm hold upon public popularity. Nevertheless, about 30 per cent. of all the arc lights are to-day operated by alternating current, a proportion which is due to secondary rather than to primary causes. The incandescent lamp has undergone in these years a far less extensive evolution than the arc lamp. It is now pretty nearly the same thing that it was ten years ago, save that improvements in manufacture have rendered the product somewhat more uniform. Chief among these we must reckon the almost universal use of the squirted cellulose filament and the introduction of the chemical method of final exhaustion. Various efforts have been made to introduce incandescent lamps of about double the usual voltage. The difficulties of construction of such lamps, their relatively low efficiency and the ease with which an alternating distribution at the usual voltages is effected constitute ample reasons for the small use of these high-voltage lamps; while the vigorous objections of the fire underwriters have discouraged any extensive exploitation of them.

The greatest change of recent years in general lighting has been the introduction of the enclosed arc lamp, which has worked a revolution in indoor lighting at constant potential as well as in street lighting. It has on the whole stimulated incandescent lighting, however, by raising the common standard of brilliancy, and by aiding in the unification of service. Considerably more than half the arc lights in use are enclosed, the bulk of the open ones being used for street lighting by companies not yet quite ready to undertake re-equipment. Of the alternating arcs more than nine-tenths are of the enclosed type, a result due almost to necessity. The introduction in recent years of series alternating arcs fed from constant current transformers is responsible for most of the use of alternating-current arcs, and practically all such are enclosed.

Through all these years of progress the incandescent lamp has held its own and has grown in relative popularity. The same virtues that gave it its start in life have kept its fortunes in the ascendant. With all its failings in points of efficiency it is to-day, as it was in the beginning, the best available illuminant in point of quality and general usefulness. Within very recent years determined efforts have been made to obtain other electric lamps of equally good qualities and of higher efficiency, but up to the present these efforts have not been crowned with success. The Nernst lamp, most admirable in some respects, is at its best in competition with the arc rather than the incandescent lamp, and is still a rarity, not yet seriously to be considered in the grand total of electric illumination. The mercury arc, another recent candidate for lighting honors, has little yet to show in the way of results, and its color is so hopelessly bad that unless remedied by some very radical step, the lamp will entirely fail of material usefulness as a general illuminant. If the public could be educated up to the point of liking the color of the mercury arc, it would already have welcomed the incandescent gas mantle to the exclusion of nearly everything else.

The incandescent lamp is then to-day as it has been all through its history, the mainstay of modern illumination so far as interior lighting is concerned. It may in due season be supplanted by something better, but that something will have to be equally steady and simple and convenient and good in color. At the present time there are nearly twenty million incandescents in lighting service from central stations in this country alone—how great a harvest from the seed time of 1879! Electric lighting has won its way into the front rank of American industries, and there it is likely to stay. Its full history cannot be written apart from that of the country's industrial growth with which it has more than kept pace.

The Development of Industrial Photometry.

By Prof. C. P. Matthews.

The science of photometry from an industrial and commercial standpoint has passed through two periods of marked stimulus. These periods have been contemporaneous with the development of the gas industry and the development of the electric light, respectively. The development of the incandescent lamp with the necessity of careful candle-power ratings, especially, has resulted in improved photometric methods. Apart from the growth and improvement of the science due to the causes just mentioned, there has been a more or less steady improvement in the physical laboratories of the world.

Notwithstanding the great improvement that has been made both as regards accuracy and speed, it must be said that until quite recently there has been a widespread tendency to regard photometric results as of very doubtful accuracy. People have grown to look askance at all candle-power measurements. Unfortunately, there has been much to justify this scepticism. Photometric results have been widely at variance. Three causes have contributed to this condition. (1) The lack of a satisfactory primary standard of light. (2) The failure to take into consideration the many sources of error in the actual process of measurement. (3) In many cases the fluctuating character of the thing to be measured. The question of a standard of light cannot be dealt with here. It may suffice to say that while the problem of a satisfactory primary standard seems far from solution, the matter of preparation and distribution of carefully-prepared secondary or working standards is being well taken care of. The Electrical Testing Laboratories in New York are prepared to issue seasoned and standardized glow lamps, which yield a candle-power in close accordance with the Reichsanstalt standards. The National Bureau of Standards at Washington is prepared to certify the standards in terms of the same unit. The action of the American Institute of Electrical Engineers, provisionally defining the British standard candle as 1/.88 Hefner units has done much to relieve the situation of doubt and uncertainty.

With reference to the errors that creep into the actual process of measurement, it may be said that, although photometry is simple in theory, it requires no little skill and judgment on the part of the operator. The science has undoubtedly suffered from the idea more or less prevalent that almost anyone can make photometric measurements.

As to the third cause of inaccuracy, it may be said that in many cases the attempt is made to measure the candle-power of a source which fluctuates in brightness in the measured direction between wide limits. Ordinary arc light photometry furnishes a good example of this. It will readily be seen that attempts to assign a fixed value to a quantity so varying as the light emitted in a given direction from the arc, would yield discordant results unless the readings are extended over a long period.

The photometry of artificial light sources may be considered under two heads: (1) Ordinary photometry, or such as deals with the integral brightness of the source; (2) spectro-photometry, or such as deals with the distribution of the brightness throughout the spectrum. Only the first-class of measurements will be taken up in this article. In considering the measurements that fall under the head of ordinary photometry, it is evident that the subject might properly be taken up under more than one classification.

We will first consider the subject from the standpoint of the relative accuracy of the results obtained. In this respect we may distinguish (1) work requiring and receiving the highest possible experimental skill. Under this head would come the study and comparison of the various primary standards of light. Naturally, in such work the highest obtainable accuracy must be aimed at. Every condition affecting the problem in hand must be studied with a view to ascertaining its importance and the correction for or the elimination of its effect. (2) Work requiring careful and conscientious measurement, but not necessitating the same degree of skill as that just mentioned. Under this head would come preparation of secondary or working standards of light in the shape of carefully seasoned and tested glow lamps. Thanks to the constancy which can be obtained in a set of carefully intercompared lamps, it is altogether possible to maintain a temporary standard of light with all necessary accuracy. Indeed, it has been shown by Sharp that copies of the arbitrary standards set up in this way can be produced with considerable greater accuracy than it is possible to secure in maintaining the best primary standard known to-day. An indefinite number of these copies can be made and placed in the hands of those requiring working standards of light. Thus, pending the development of an invariable primary standard, we shall at least be in fair accordance as regards our working standards of light. And furthermore we shall have the means at hand through the National Bureau at Washington of checking our standards at any time.

The subject of ordinary photometry may also be subdivided according to the character of the measurements. These may be either unidirectional or integral. Early photometric measurements were entirely of the first class. Experimenters were content with candle-power in a single direction, usually horizontally and normally to some specified aspect of the source. For example, the candle-power of a gas flame is understood to be the result of a measurement made in a direction normal to the broad side of the flame. A similar measurement was applied to earlier forms of the incandescent lamp. Measurements of this kind are necessarily a basis of all curves of candle-power distribution, and hence are an invaluable aid to the study of artificial light sources.

The simplest example of the second-class of measurements is the determination of the mean horizontal candle-power of an incandescent lamp by making a photometric setting while the lamp is spun on a vertical axis. Lamps are rated commercially to-day by this method. Obviously, the method is applicable to any source which can be rotated at the required speed without altering its light-giving value. The determination of the mean spherical candle-power of a light source at a single setting furnishes another example of an integral measurement. By means of the apparatus developed by the writer, it is possible to make the spherical measurement with all the ease and celerity obtainable in the simplest photometer setting. Moreover, the accuracy of such measurements is as great as that to be secured in the longer and more laborious methods. It is not, perhaps, out of place to say that a form of the apparatus less expensive than that originally put out is now being introduced.

The Unchangeableness of the Three-Wire System.

By Charles L. Edgar.

I do not suppose that, in the history of the world, there has ever been an industry which has shown such tremendous growth in a quarter of a century as that with which your paper has to do. To say that you not only have kept the pace, but have actually made the pace many a time is, I think, a compliment which is your due. You are to be congratulated on your work and we are to be congratulated that our industry has such a paper.

On looking back over the years there is, in my mind, one thing that stands out above all others, and that is the unchangeableness of the Edison three-wire system of distribution. If we look back to 1883 and go over the plans of the Sunbury station, especially its switchboard connections, its feeder system and its distribution of mains, we will see that it is an exact duplicate, in miniature, of what is now being used in the large cities of the country. Changes due to the enormously increased quantity of current have been very great, but the fundamental principles laid down by Mr. Edison a quarter of a century ago are still recognized to-day in designing all comprehensive systems of distribution. It is perfectly true that instead of locating small steam stations at regular intervals throughout the city, as was done in the early 80's, we are manufacturing our electricity at high tension at a distance and transmitting it to what are now called sub-stations, but from that point on the quarter of a century has changed only the details; the principles are the same. Even in details, the changes are less than one would imagine. The feeder regulator has given way to the multiple bus; the mains have become larger and the feeders, relatively speaking, fewer, as time has gone on. The wires have been taken down off of poles and put underground; the catch box of to-day is an exact duplicate, in theory, of the distributing pole of the Sunbury days. It is merely underground, carries more current and has a few more refinements. The low-tension switchboard of the modern station of to-day was designed in 1882 and has only been multiplied a hundred times. So we could go on, item by item, and a whole book could be written, all going to show that in the wonderful advance which has been made in an industry which is to-day one of the most prominent in the world, the three-wire system stands unchanged—a monument to the genius of Mr. Edison.

The First Electric Street Car in America—1884.

BY E. M. BENTLEY.

ON July 27, 1884, an Associated Press dispatch was sent out from Cleveland, Ohio, as follows:

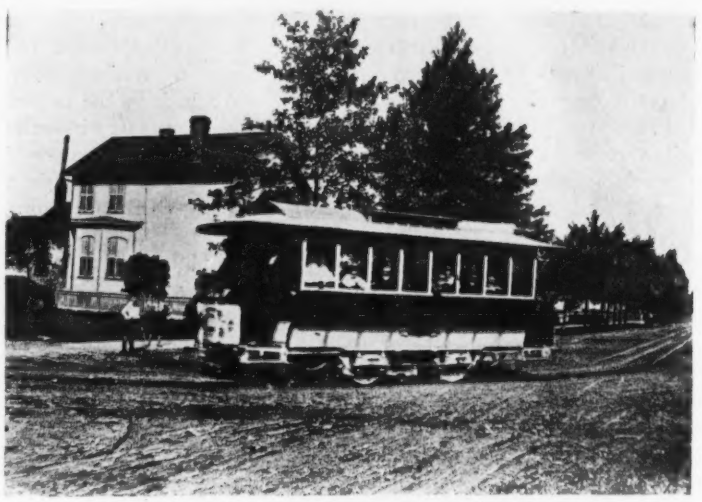
"The first electric railroad for public use in America went into operation in this city yesterday in connection with the East Cleveland Street Railroad Company, which has just completed a mile road. The experiment was so successful that the company expects to change its entire system, comprising over 20 miles, into electric roads. The Bentley-Knight system was used and the current was carried on underground conductors laid in conduits like those of cable roads. The cars were started and stopped and reversed with the greatest ease. Any number of cars up to 15 can be run at one time on a single circuit and from one machine, which is a result not attained by any of the European systems now in operation. The success of the new road has made a great sensation in both street railroad and electrical circles, and is expected to greatly extend the field of electrical development, as well as enhance the value of street railroad properties."

The occasion for this enthusiastic dispatch—which is not without some prophetic truth—was a single electrically-driven street car, that had for many years traveled up and down the streets of Cleveland behind two car horses, such as are now happily obsolete. Going back fifty years or more, we find many instances, both in this country and abroad, of scientific toys, comprising a small motor mounted on a truck and supplied with battery current through the track rails. Indeed, the advent of the battery as a source of current gave rise to many suggestions which we have only seen realized in recent years. Prior to 1884 Mr. Edison had also constructed his well-known pioneer roads at Menlo Park, N. J., one in 1880 and the other in 1882, in both of which one track rail had served as the outgoing and the other as the return conductor of the circuit. Mr. Daft had also been experimenting, having operated a short length of track on the pier at Coney Island in 1884, while in 1883 he made a few trips with an electric locomotive drawing a passenger car on the Mt. McGregor Railway near Saratoga. He, too, employed the track rails for his respective conductors. Indeed, he once took out a patent on an electric railway, in which the novelty lay in the low potential which he purposed to use; 30 volts was the upper limit of his low potential and the rails were to be "practically uninsulated." This is mentioned in passing to indicate what a blank wall of inexperience confronted the early experimenters. Mr. Edison was then dreaming principally of a high-speed road from New York to Philadelphia and Mr. Daft's efforts were in the same direction. Many other projects of that date seem even more preposterous in the light of our present knowledge.

Mr. Knight and myself, perhaps more than others at that time, were impressed by the fact that the immediate need for electric railways was in the city streets, and that the use of one rail as a positive and the other as a negative conductor, or even a live third rail, was not feasible for this purpose. There was also an active agitation then in progress against overhead wires, and so we undertook at once the development of our ideal, namely the conduit system, or, as it is now usually known, the underground trolley, quite unconscious that we were extremely premature.

The street car track of those days was simplicity itself, and it was several years before the average street railway superintendent could be brought to believe that an electric car deserved anything but the worst piece of track on his road. The ties were first laid down 5 ft. apart and upon them were placed the two longitudinal wooden stringers 6 or 8 in. in depth and upon the stringers were spiked strap rails, weighing 35 or 40 pounds to the yard. The switches were merely cast-iron plates inserted at the branching points of the track. There was a prejudice against movable tongues on switches. In some of the more elaborate roads tongues were employed, operated by a tilting table, the horses walking on one side or the other of the table to throw the switch, but more commonly the horses would be turned to one side or the other of the car to drag it laterally across the switch plate to make it take one or the other of the two branching tracks. An objection gravely urged against electric cars was that there would be no horses to pull the cars sideways at the switches or to walk on the tilting table. This track construction, although universally used, deteriorated rapidly. The surface of the stringers, being alternately wet and dry, soon rotted and invariably rotted in spots so that the flexible strap rails quickly assumed a wave form, and the light cars, with their short wheel bases would go bobbing along like a ship at sea. The outfit of the repair gang was correspondingly simple, comprising an adze, a crow-bar, a sledge hammer, a bag of spikes and a bundle of "shims." It was an easy matter to pry off a rail, adze off the rotten surface of the stringer, lay in a "shim" and spike the rail in place again. I have referred to this matter to indicate the nature of the conditions encountered by the pioneers of the electric railway, it being manifest that electric railroading on a track of this description was no easy matter. It was, however, but typical of many other difficulties besetting the situation.

It was on a track of this kind, along a section of the line of the East Cleveland Street Railway Company, that the car in question was first operated. The route began on what was then known as Garden Street, two blocks west of Wilson Avenue. From Garden Street it turned into New Street, and then into Quincy Street, and was at first about a mile in length, but was soon after extended across the Cleveland & Pittsburg Railroad tracks and thence along Quincy Street to Lincoln Avenue. The conduit was of wood, excepting about 100 ft. at the crossing of Wilson Avenue, which was of iron. Rectangular cast-iron yokes were set on the ties and outside of the yokes were two-inch planks, set on edge to form the sides of the conduit, while similar planks formed the top, with a slot having an original width of three-quarters of an inch. Inside the conduit



FIRST ELECTRIC STREET CAR, CLEVELAND, OHIO.

were the conductors, formed of channel bars about four inches apart and supported on insulators projecting from the wooden side walls of the conduit and entering the groove in the rear of the channel bars. On this crude line of construction there were worked out several curves, also the branches for a turnout and for one spur track and—most difficult of all—a railway crossing through the Cleveland & Pittsburg tracks. The current for the road was supplied at first from a Brush arc light machine, No. 7, driven by a 25-hp engine in the car barns at Euclid Avenue, a quarter of a mile away, and to one old gentleman, a director of the road, it was a constant source of wonder that, after throwing the switch, it took such a short time for the current to come from the car barns to the road. The first car was equipped with another Brush arc light dynamo, No. 6. It was suspended directly underneath the center of the car body, the shaft extending across the car. On the driving end of the shaft were two pulleys, each having a series of half-inch grooves in its face and from these pulleys belts of coiled steel wire extended in opposite directions to counter-shafts on each end of the car, which, in turn, were similarly belted to the axles. This mode of gearing had been the outcome of considerable experiment, and it must be said that, for a few days, the operation was all that could be desired, there being no slippage of the belts, while there was a yielding spring start which was easy and agreeable. In the course of a week or two, however, the springs were breaking with a loud report, at the rate of about one an hour, and, until the passengers got used to it, there was a serious commotion among them each time that it occurred. At first the breaks were at the couplings, but when this was finally overcome the wire itself began to give way, indicating that, for steady work, the duty was too severe, crystalization of the wire resulting in a short time; nor could it be obviated by any kind of wire then available. The belts were, however, kept going until a second car was equipped with a different transmission scheme. On

this car the motor shaft was equipped with a friction wheel made of discs of strawboard solidly compressed. Outside of this pulley and around it were grouped three similar pulleys, one of them larger than the other two, and outside of the three was a shell, the four pulleys having a sort of eccentric compression against the shell, without strain on the bearings, and the shell was mounted on a separate shaft and connected by link belts to the car axle. This device likewise worked well for a time, but one day the friction wheels began to slip under a heavy load, developing flat spots at once and the usefulness of the contrivance was at an end. A third car was then equipped with spur gearing, the body of the gears being built up of paper like a paper car wheel. By this expedient the noise of the gearing—which had been one of the reasons for not employing spur gears at first—was deadened to a satisfactory degree. The motor shaft had a speed of 1,500 and we could find at that time no precedent for the use of spur gearing at that speed. In this third car the motor was carried by a separate truck, its shaft lying longitudinally of the car and gearing with a parallel counter-shaft, which drove the two axles by bevel gearing. This eliminated for a time the difficulties involved in the mechanical transmission between the motor and the car.

The regulation of the motor and its reversal was extremely simple so long as we were working with a constant current, it being only necessary to move the brushes around the commutator both for reversal and for speed adjustment. From the brush-shifter a rod extended to each end of the car where, by means of a simple lever, the entire control of the car was secured. We had, at the outset, been possessed with the idea that the cars might be operated in series with a constant current, a scheme which was quickly abandoned by us, although a few years later Mr. Short, in Denver, made a brave attempt to operate such a system and succeeded in running six or seven cars in that manner. It should be said that the series arrangement was our plan for long-distance and high-potential work, though we gave it a brief, but unsuccessful, trial on our Cleveland road.

Mr. Short, on the other hand, used the form devised by Fleeming Jenkin, who was the first to propose the series system. The line was divided into sections shorter than the length of the car with a spring jack between each section and its neighbor. On the car was a plow, as long as the car, and serving, in effect, as a plug for the jacks, taking into a jack ahead before leaving the jack in the rear.

After giving up the idea of constant-current operation, there followed a long chapter of experiments for the working out of motor-regulating devices for constant potential, which culminated in the contrivance of a regulating rheostat of sheet-iron plates in superficial contact, such as was afterwards used by the Thomson-Houston Company up to the time that the series multiple method was brought into use, about 1892. It should be remembered that constant-potential circuits at 500 volts were then unknown, and that there was little or no precedent for the control of motors of the size needed for railway work, even on 100-volt circuits.

Another source of serious tribulation was the plow for maintaining connection between the car and the conductors in the conduit, this problem being intimately associated with the matter of the bad roadway, which at that time appeared to be indispensable. It seemed necessary to anticipate that a car would jump the track at least once a day, and, whatever the future might have had in store, it was then an absolute requirement that a car should be permitted to leave the track as frequently as it desired without wrecking the plow. This point having been established, we met the situation by means of a plow so constructed that it could be thrown out through the slot at any point and so hung on the car that it would be tripped and swung up out of the conduit, if it encountered any obstruction such as the end of a loosened plank on the conduit, or if it should bind in the slot when the car went off the track. Manifestly, the requirement that the plow should be capable of coming out through the slot imposed limitations on the size of its parts and in consequence there was liability of breakage while, moreover, with such insulating materials as were then available to the art a "ground" was not unknown. It was only after the art was so well advanced as to make it reasonable to expect a car to stay on the track, that the construction of a substantial and reliable plow became feasible. It was some years, however, before electric cars were deemed worthy of having a new track laid for them. It was considered their duty to travel on any old track that might happen to be already on the ground. It may be mentioned that the "plow" originally received that designation from the fact that in one of our earliest schemes, which fortunately was never attempted in practice, the top of the conduit was made up of hinged sections that were to be lifted as the car proceeded by means of a device which was naturally designated as a "plow," a name which has since clung to it.

The success of this road, as a factor in actual service, was really greater than might have been expected. At first the passengers coming up from down-town transferred to the electric car and were taken by it to the end of the route, while, after the third car was in use, it took the horse cars through as trailers. A week or ten days of uninterrupted service would be followed by several days of repair work. The object of the enterprise was, however, to test out the value of different devices by subjecting them to service conditions, and not to do the actual work of the railway. Winter running was particularly uncertain, but we demonstrated the ultimate possibility of it to our satisfaction. The road was operated for over a year, but the construction was, in its nature, temporary. Besides the wooden conduit, the streets through which we ran were sewerless, and about to be torn up, while we were then unprepared to replace the wooden conduit with a steel one or to provide the additional material required for a permanent plant, even if it would have been commercially warranted in that location. There were also people who could not be brought to believe that a Brush arc light dynamo was not an ideal railway motor, or was susceptible of improvement for that or any other purpose. In consequence we had to continue the development of the conduit system elsewhere—at Providence, at Allegheny City and finally at Boston, where it met its rival, the overhead trolley, and came to grief, not to revive again for ten years.

At the "Lab" Twenty-Five Years Ago.

BY A. E. WINCHESTER.

Good friend, receive the heartfelt and sincere congratulations of the humblest of the old-timers upon the attainment of your prime and hearty age of thirty years crowned with success, and the fact that you are looked forward to weekly with warm welcome wherever "currents" and "watt-berries" grow. May success abide permanently with you! Is it possible to give adequate expression to thoughts that flash through the mind of one trying to briefly review what science and electricity have wrought within the past quarter century? A history of untold volumes telling of man's great deeds of evolution and revolution. Did time and space permit, the task would be too great for me.

Looking from a window in the South Norwalk municipal electric works, I see a man in the distance; how slowly he walks, how small he looks. Viewed outwardly, how insignificant is man, after all. Divested of intellect, he is the most helpless of creatures. But endowed with reason, his physical weakness is not seen; he is master of all living things, and nature's forces respond to his touch. Electricity by his will has changed, within our memory, from a dreaded mystery to the most useful and familiar agent of our commercial and social existence. When, as a green run-away school-boy, I entered the budding Edison interests, every one connected with the meager science knew, or seemed to me to think they knew, all there was to know about the applications of electricity. It happened that I was soon assigned to do some work for Mr. Edison at the laboratory. I will never forget the sensation of awe that I felt as I stood gazing at the "old man," as he was called in endearment by his boys. He with characteristic unconsciousness worked away on his feeder-and-main scheme, without seeing me, until some one slapped him on the back and shouted in his ear, "Say, Tom, don't you see that chap wants to talk to you?" "Then why don't he talk?" was the ready reply, accompanied by a keen glance,—and after reading my credentials, a friendly smile. A grimy hand was shoved out to me. That was many years ago, but I will never get over being proud that a hand of mine shook the hand of Edison. Something about me, perhaps it was my modesty—I was still new to the business—reminded him of a story which had to be told before further operations could proceed. It was a good one, one of his "specials;" I remember it well, because others have since tried to work it off on me as original goods. Maybe I will whisper it as a familiar reminis-

cence of the "old man" sometime later, where the ventilation is good. When I left the laboratory that night, my hat fitted snug upon an expanding brow. I knew it all—all about filaments, lamp construction and the theory of sub-divided current. I thought I did, and was rather "chesty" to my less favored associates. However, the shrinking process came to my rescue in due time, and I have kept shrinking ever since, until now you can't find my little glim among the great lights of to-day.

But those early days brimmed full of exciting experiences, failures often and triumphs occasionally, but big ones when they came—lamps without life, others with too much, "shorts" that would not burn out, and armatures a-plenty that would, as the old boys can well remember. The bitter and the sweet of those times will never be tasted by those more recent in the field, because the days of the "rule of thumb," "cut and try" and "guess again" have passed out of operative electricity, and things are done right the first time now, because those old fellows of years ago found out how. The old-timers hewed their way up from the wilderness of obscurity to light, and left a broad path behind them reaching high up on Mount Progress to the zone of success for future generations to follow upward also, unhampered by doubts.

The Progress of Telegraphy During the Past Thirty Years.

By WILLIAM MAVER, JR.

WHEN one regards the vast extent of the present-day applications of electricity, it is difficult to believe that thirty short years ago—less than the one-third of a century—the chief, indeed it may almost be said the only, important use of that force was in its application to electrical telegraphy. Yet such was the case. In the year 1874 the dynamo-electric machine, that revolutionizer—in fact, the creator—of many of the industrial arts of the greatest magnitude, was known, it is true, and the fact that it was reversible had already been discovered—a discovery that ranked as one of the most important of the nineteenth century. But its use was then very limited, and the crudity of the machine at that time is well exemplified by the manner in which the manufacturers of the period graded its capacity, namely, by saying, in all seriousness, it was equal to so many Bunsen cells; that it would take so many horse-power to drive it, or that it would heat a platinum wire of a certain length and thickness. The latter method of defining current strength, it may be noted, was also resorted to by the earlier experimenters as a means of designating the strength or capacity of Leyden jars. (*Query.*—Thirty years hence will some retrospective or reminiscent writer have occasion to note that the manufacturers of 1904, in all seriousness, defined the output of their generators of electromotive force as so many kilowatts, 90 per cent. efficiency, etc.?)

To show more clearly the progress of electrical telegraphy during the past thirty years, it may be advisable to refer briefly to the state of that art at that time or shortly prior thereto. Up to 1872 all overland wires, as well as the long submarine cables in this country and elsewhere, were worked single, as it is termed; that is, but one message was sent at a time over one wire. In this country the Morse manual telegraph system was, with the exception of the House and the Phelps printing telegraph systems, the only one in operation. The speed of transmission by the Morse manual method was from 20 to 40 words per minute, depending on the skill of the operator. The speed of the Phelps printer was about 50 words per minute. In Europe the systems most in vogue were various types of needle and dial telegraphs, together with the Hughes printer. The Atlantic cables were in operation, working at a speed of from 10 to 12 words per minute. In Great Britain the Wheatstone Automatic was working singly at the rate of 80 to 100 words per minute. Galvanized iron wires of No. 4, 6, 8 and 9 gauge, were used exclusively for overland purposes, and primary batteries, such as the Callaud or the Grove, were the only sources of e.m.f. employed on telegraph lines.

In 1872 a most important advance in the art of telegraphy was made in the application of the condenser to the Stearns duplex, which duplex had been introduced two or three years previously on the telegraph lines of this country. This invention by making it feasible to send two messages at once over one wire, doubled the capacity of all through overland wires on which it was applied; and it was not long thereafter before the duplex principle was successfully employed on the Atlantic and other long cables.

In the meantime Edison was assiduously working to perfect a quadruplex system of telegraphy by which four messages might be simultaneously transmitted over one wire, and in 1874 his efforts were rewarded with success. This achievement practically quadrupled the capacity of the through overland wires and thereby added thousands of miles to the existing facilities of the telegraph companies and governments employing it. It has been said by a recent imaginative writer that the quadruplex system sprang fully equipped in one night from the inventor's brain. The present writer has a clear recollection of rumor current at the time that the perfecting of the quadruplex was the result of many weeks and months of arduous toil, during many nights of which the inventor, when he slept at all, slept on the floor or on a bench beside the apparatus.

By the application of the duplex principle to the Atlantic cables the capacity of each cable has been doubled. This is likewise true of the land circuits on which the Wheatstone automatic system is employed. So that to-day, with other refinements in the art of submarine cable working, including the automatic transmission of messages, the capacity of an Atlantic cable is now about 22 words per minute in each direction. In Great Britain the capacity of a circuit employing the Wheatstone automatic system is now from 200 to 400 words per minute, depending on the length and other conditions of the circuit, in each direction.

During the past 30 years a number of rapid automatic telegraph systems have been tested in the United States, notably about 12 or 20 years ago, when more than one company was engaged in exploiting certain chemical and other automatic telegraph systems, to be operated at from 800 to 2,000 words per minute. But from various causes these systems were not permanently adopted, and the lines built for them were absorbed by companies operating on the manual Morse system. In Europe, within the past few years, several rapid automatic telegraph systems, capable, it is claimed, of transmitting messages at the rate of several thousand words per minute, have been tested; but it is not known that such systems have as yet gone into actual operation. The matter of rapid automatic telegraph transmission versus the Morse manual method, which later is practically the only one employed in America, Australia, New Zealand and largely in Europe and Great Britain, is a vexed question. There are those who consider that the retention of the Morse manual method is an evidence of backwardness on the part of those employing that system. But it should not be overlooked in this relation that the manual Morse method has of recent years gained ground in Great Britain and Europe generally, to do which it had to displace the one-time, almost generally employed, needle and dial systems. Furthermore, in Great Britain, where automatic telegraphy has been for many years in constant operation, and where, in fact, chemical automatic telegraphy had its birth, automatic telegraphy is to-day confined to the comparatively slow-speed Wheatstone system, which system is, it may be remarked, in great measure but a refinement of the Morse manual method of transmission.

On the continent of Europe the needle telegraph is still somewhat extensively employed. In France the Baudot synchronous printer, by which four messages are simultaneously transmitted over one wire, is now utilized on all the important through circuits, and affords a capacity of about 110 words per minute to each circuit. In this system, as well as in the case of the Hughes printer, which is also employed largely in Europe, the message is printed on a paper strip as received.

In this country the Buckingham printer, which operates at a speed of about 100 words per minute, in each direction, is employed on circuits from 500 to 1,000 miles in length. By this system messages are printed in page form on the ordinary telegraph blank as received. Two other important page-printing telegraph systems, namely, the Murray and Rowland, are now being experimented with in this country and Europe.

An important innovation in the method of preparing messages may be mentioned in the case of the Buckingham keyboard perforator, which was initially designed to prepare messages for transmission by this system, but which is now also used to prepare messages for transmission by the Wheatstone automatic system, employed on a number of circuits here, almost to the entire exclusion of the mallet method of preparing the messages. The keyboard method more than doubles the rate at which messages may be prepared for automatic transmission as compared with the mallet or hand-perforator. As an instance of this, it may be noted that one operator has perforated 850 messages in 11 consecutive hours by the keyboard perforator.

Among other developments of electrical telegraphy in the last 30 years has been the Delany synchronous system, which transmits four to six messages at once on one wire. This system has been employed in Great Britain for some years. The messages are transmitted manually at the ordinary rate. Another exceedingly valuable invention of recent years is that of Van Rysselberghe, by means of which it is possible to telegraph and telephone over the same wires at once; that is, while the two wires of the telephone circuit are being utilized for the transmission of speech on long-distance wires, both wires may at the same time be employed for ordinary telegraph purposes. In this country many telephone circuits are, by means of this system, operated also as telegraph wires. On the other hand, the telegraph wires of the country are used exclusively for telegraph purposes, but little effort having been made, it would seem, to utilize telephony as an adjunct to the regular business of telegraphy, which has long been an occasion of some wonder to the writer, although he is not unmindful of the difficulties of the matter. It should, however, be added in this relation that some of the telegraph wires of the railway companies of this country are utilized for simultaneous telegraphy and telephony. As long ago as 1890 the writer connected up the first set of apparatus for this purpose in the New York office of the telephone company for an experimental circuit between that city and Philadelphia.

As soon as the dynamo-electric machine was shown to be a practical source of e.m.f., it was quickly employed by the telegraph companies for that purpose, the first installation of which was made in the Western Union building in 1880. Since then primary batteries have been entirely dispensed with in all the large telegraph offices, dynamo machines or storage batteries replacing them. In 1884 the extensive employment of hard-drawn copper wire was begun by the telegraph companies, and its use has continued up to the present time, although large quantities of iron wire are still used in the telegraph service.

Still another obvious improvement in the telegraph service that has taken place in this country within the last decade is the general use of typewriters by the operators for the reception of business. This is not only more satisfactory to the public, but is a boon to the operators employing the typewriter, as it reduces the work of transcribing the messages to a minimum. Another recent improvement in this direction is the use of the typewriter keyboard as a transmitter of messages by the Morse alphabet; depression of a key effecting the transmission of dots and dashes corresponding to the letter represented by the key so depressed.

In one respect, however, it must be noted that within the last eight or ten years there has been a falling off in the efficiency of one branch of the telegraph service in this country, namely, that of the quadruplex system. This falling off in the efficiency is due to disturbances caused by the proximity of the wires of electric traction and other high-potential systems, and other causes, which appear to impair the operation of what is termed the "second" side of the Edison quadruplex system. Whether these causes of impaired efficiency will be overcome remains for the future to determine.

After all, the progress of electrical telegraphy in the past 30 years will perhaps best be shown by a comparison of the amount of wire then in operation for telegraph purposes, and by the number of messages then annually transmitted, with the mileage of telegraph wire now in use and the number of telegraph messages now transmitted annually. In 1874 there were perhaps not more than 150,000 miles of telegraph wire in this country; to-day there are over 1,000,000 miles of such wire in service, a large portion of which is either duplexed or quadruplexed. Thirty years ago not more than twelve or fifteen million telegraph messages were annually transmitted over the telegraph wires of the world. Now probably over 300,000,000 of messages of all classes are transmitted every year. This large volume of business is the more noticeable when the amazing growth of the telephone service is considered, and one is led to wonder what the extent of the telegraph service might have been had the telephone not appeared on the scene; for, while in many cases the telephone acts as a feeder for the telegraph, it is idle to pretend that the former does not in multitudes of instances take business that would otherwise have gone to the telegraph. In connection with the number of messages handled by telegraph, it may also be pointed out that within the last 15 or 20 years many of the largest users of the telegraph in this country have leased wires from the telegraph and telephone companies for private use, over which wires hundreds of thousands of messages are transmitted which do not appear in the public record as business transacted.

A record of the progress of telegraphy, however brief, could not, of course, be complete without reference to wireless telegraphy, the advent of which within the past five years has excited more popular interest than any means of transmitting intelligence to a distance that has been evolved within half a century. That art is now feeling its way and it will probably soon reach a substantial basis. Thus far many of the promises concerning its scope have not been fulfilled. It has hitherto fallen far short of providing transatlantic telegraphy, but its field of usefulness as a means of communication between vessels at sea and between vessels and the mainland is enlarging daily. Already it has demonstrated its value in many important instances, and with its increasing application to a larger number of vessels, to lighthouses, lightships, etc., its utility will be at least proportionately enhanced.

Fads in Engineering Practice.

BY S. T. DODD.

IT is generally understood that engineering practice is dictated by engineering formulas, or practical commercial and financial considerations, and it might be supposed to be free from those waves of sentiment which often control masses of men in politics or religion, or which we call fads when we encounter them in the region of art and literature. It is very interesting to note, however, that the development of engineering practice is often accompanied by sudden revulsions which are not always guided by the best engineering considerations.

An instance of such revulsions is seen in the sudden demand during the last year for turbo-generators. Less than two years ago the discussion of a paper before the American Street Railway Association at Detroit, showed that there was a general timidity among operating men, as well as engineers, in regard to accepting the turbo-generator as a suitable unit for railway and power work. Engineers have not, up to the present time, had a very wide experience with turbines under fluctuating power loads, but the engineering profession in general seems to have gone to the other extreme in its acceptance of the turbine as a satisfactory and final form of prime-mover.

A representative of one of the large manufacturing concerns said to the writer the other day: "The country has gone turbo-crazy and hardly any consulting engineer dares to advocate reciprocating engines for fear he would be considered behind the times." While all the experience we have had up to date seems to indicate that the claims of advocates of the turbine are fairly borne out by practice, it hardly seems that this experience is sufficient to justify the sudden unanimous and overwhelming relegation of the reciprocating engine to the realm of out-of-date apparatus which the present tendency would seem to indicate.

Another fad which is based on still less valid considerations is the demand for increased sizes of cars on interurban electric roads. Ten years ago the first interurban cars on the Akron, Bedford & Cleveland Railroad weighed about 19 tons loaded, and had a seating capacity of 40 passengers. Since that time the technical press has been continually advocating the advisability of operating interurban roads along the lines of steam railroad practice, and some managers appear to have understood this as an advocacy of steam railroad cars for interurban railway service.

At any rate, we have noted, from time to time, in manufacturers' notices or descriptions of new roads, the increasing size of cars. The greed for greater seating capacity has increased the length of the cars to 45, 50 or even 60 ft. over all, the increase of weight of body necessary for rigidity, the introduction of hot-water heaters, air brakes, multiple-unit control, and the various paraphernalia of modern equipment has forced larger sizes of motors, greater weights of trucks and size of axles, and finally those of us who are conservatively inclined doubt very seriously whether, excepting in an advertising sense, the increased earning capacity of a 50-ton interurban car driven over tracks at 60 miles an hour with 500-hp of motors under it really justifies the increased first cost of the equipment, or the increased watt-hours per passenger carried, which are necessary to operate it under the conditions of grades and stops which we have to encounter.

It is refreshing occasionally to meet, as the writer did recently, a sane railway manager, who admits that his new interurbans are not proving the money-earners that he had expected; that his road has built up the resident population along his line; that with his increased stops he finds it pays him to reserve his new cars for

limited and special runs, while he operates his old cars on the regular runs, and who says that when he is next in the market for equipments, he will go back to smaller cars and equipments with which he can make his frequent stops and keep his schedule without forcing the excessive fluctuations of loads on his power house and sub-stations which his new cars are demanding.

The writer believes that the modern demand for large size and excessive speeds of interurban electric cars is in the great majority of instances a fad which is not justified by considerations of economy or good engineering. One of the most annoying features of this development is the tendency of unscrupulous or ignorant promoters of new electric railway propositions to fill their prospectuses with specious arguments based on apparently accurate data of existing roads. Our reputable engineers are called on continually to combat such projects which show an earning power based on cars nearly equal in weight to Pullman sleepers running at speeds which are an engineering impossibility with any reasonable stops and grades, while the capacity of the equipment, the first cost and operating expenses are figured on the basis of existing roads operating cars of medium weights at reasonable speeds and giving satisfactory service to the territory they serve.

To-day we are confronted by the promise of a new fad. Any one who is familiar with the electric railway situation in the Middle West cannot fail to be impressed that the widespread interest which has been excited by the alternating-current motor. Speculation is rife among engineers as to whether we have not arrived with it at the solution of voltage limitations and distribution troubles incidental to our present practice on suburban and even on city lines. It is seriously questioned whether it would not pay to scrap existing apparatus and replace it with alternating-current railway equipment. The writer does not wish to be understood as saying that there is not a great field for the alternating-current, single-phase railway motor, or that the field which it will open will not be one that is as yet practically untouched by electric railway apparatus; but he does seriously question whether, except in special instances, existing electric roads could be advantageously improved in economy by the substitution of alternating-current equipments for their present apparatus. Electrical apparatus, like the rest of mankind, "is of a few days and full of trouble," and whether the maintenance and operating expense of alternating equipments will be less than direct-current equipments can only be decided by extensive experiments.

In the meanwhile, the time is now ripe for a careful conservative discussion of the engineering, commercial and financial questions bearing on the advantages and disadvantages of alternating-current railway equipments on interurban roads running over highway or private right-of-way, as we know them to-day. As the writer sees the situation, such a discussion at the present time and a clear understanding of the principles involved would save in the near future a considerable investment in costly experimentation on some propositions, the result of which, on general principles, might have been expected beforehand.

Expansion and Changes of Electric Light and Power Systems.

BY ALTON D. ADAMS.

EXPANSION of electric systems has been accompanied by constant changes in the character and relation of station equipments and the connected loads. Perhaps none of these changes have been more notable than those in the relations of connected loads to station capacities and operation. During the first decade of electric lighting from public systems the combined capacity of street lamps and commercial lamps and motors was generally less than the capacity of the generating apparatus in stations to which they were connected. This condition continued up to about 1890, but since that year the lamps and motors supplied with energy from public electric systems have shown an almost constantly increasing excess of capacity over that of the generating stations to which they are connected. An illustration of this fact is found in the figures for total generating and connected capacities in the electric lighting systems of Massachusetts in each year, from 1888 to 1900. On June 30, 1888, the total capacity of dynamos in all the electric lighting stations of Massachusetts was 6,842 kw, and on the same date the lamps and electric motors of all sorts connected to these stations had a combined capacity of 6,117 kw. Twelve years later, on June 30, 1900, the generating capacity of the stations had increased to 68,941 kw, or to 10 times the like capacity for the earlier year.

During the same period the combined capacity of lamps and motors supplied from these stations rose to 96,650 kw, or 15.8 times the connected capacity in 1888. The total capacity of connected apparatus was 89.40 per cent. of the station capacity in 1888, but every subsequent year showed an increase of this per cent. and it stood at 140.19 in 1900. In 1888 the maximum load of electrical supply stations might well be the entire connected load of the systems, and as a matter of fact this was often substantially the case. In 1900 a little more than two-thirds of the capacity in lamps and motors connected to the systems was sufficient to tax the generating equipments to their full rating. For example, see the following table:

Kilowatt capacities of dynamos and connected loads of lamps and motors for electrical supply stations in Massachusetts:

Year of June 30.	Dynamo capacities.	Capacities of lamps and motors.	Per cent. of lamp and motor to dynamo capacities.
1888	6,842	6,117	89.40
1889	10,074	9,599	95.28
1890	15,244	14,458	94.84
1891	18,593	20,441	109.93
1892	21,188	25,701	121.30
1893	26,953	30,178	111.96
1894	31,749	38,522	121.33
1895	33,256	44,592	134.09
1896	40,226	54,850	136.35
1897	45,461	64,501	141.88
1898	50,490	73,028	144.63
1899	63,020	83,943	133.20
1900	68,941	96,650	140.19

The great increase of capacity in connected loads compared with dynamo capacities has been made possible mainly by three important factors. These are storage batteries, residence lighting and motor loads. Storage batteries have operated directly to cut down the required capacities of dynamos by carrying a considerable portion of the maximum load. The ultimate effect of storage batteries has obviously been to lengthen the hours of daily and yearly operation for generating apparatus. What storage batteries have done indirectly, residence lighting and motor loads have done directly by demands for energy at times of day when street and business lighting was not required. The increase of average electrical loads since 1888 has probably not been as rapid as the rise of connected loads. This conclusion follows because lamps in residences are in use a smaller average number of hours daily than lamps in business houses, and from the fact that electric motors, though often operated more hours per day than lamps, often run on loads much below their rated capacities. Maximum loads find their limits not in connected lamps and motors, during recent years, but in the capacities of station dynamos and storage batteries. In 1888 the capacity of all connected lamps and motors was less by 10 per cent. than that of the station dynamos by which they were supplied. In 1900 these lamps and motors had a capacity 40 per cent. greater than that of station dynamos.

Storage batteries had not begun to play their part in electrical supply to any considerable extent in 1888, and dynamos alone represented the entire capacity of stations. To have given electric stations capacities the same relation to connected loads in 1900 that they had in 1888, these capacities must have stood at 108,109 kw in the later year. This could have been done with storage batteries capable of discharging during a period of two to three hours at the rate of 39,168 kw, but the capacity of the batteries actually in use seems to have been much below these figures. Though the increase of average loads has fallen behind that of connected loads, it may well have exceeded the rise of maximum loads as indicated by battery and dynamo capacities.

Within electric stations changes have been going on not less marked than the relation of dynamo capacities to outside loads. From 1888 to 1894 the number of engines in the stations of electric lighting systems rose with the sum of their capacities, though not at so rapid a rate. This was the era of comparatively small high-speed engines, each belted to one or two dynamos. During these six years the number of engines rose from 149 to 347, or to 2.3 times that of the former year. Meantime engine capacities went up from 11,515 to 54,729 hp, or 4.7 times the earlier capacity. At the beginning of this

period the average rating of each engine was 77 hp, and in 1894 this rating stood at 157 hp. In other words, not only the number of engines, but also their average horse-power more than doubled between 1888 and 1894. Beginning with 1895 a marked change in the engine situation set in. In this year the number of engines showed a decline for the first time during the entire period, though there was a small increase of capacity. This effect was probably due in large part to the introduction of comparatively large engines direct-connected to their dynamos. In 1895 the number of engines in electric lighting stations throughout the State was 319, and stood at 343 in 1900, having touched its highest point, of 352, in 1899. Meantime, the total horse-power of these engines went up from 55,548 in the earlier to 80,115 in the latter year. This increase of engine capacity carried the average horse-power per engine up from 174 in 1895, to 248 in 1900. During the twelve years between 1888 and 1900 the number of engines was multiplied by 2.3, the average horse-power by 3.2, and the total horse-power by nearly 7. Dynamos in electric lighting stations began to decline as to numbers after 1893 and again after 1897, having gained nearly 50 per cent. between these years. In 1897 the figures for dynamos had advanced to 975 from 348, in 1888, but by 1900 this maximum had fallen to 827. Total dynamo capacities exhibit an unbroken advance from 1888 to 1900, and this is also true of average capacities, except for the years of 1896 and 1897.

Numbers and capacities of engines in private electric lighting stations of Massachusetts:

Year of June 30.	Number of engines.	Total horse-power of engines.	Average horse-power of engines.
1888	149	11,515	77.3
1889	199	18,752	94.2
1890	254	27,199	107.0
1891	280	34,453	123.0
1892	309	41,499	134.3
1893	333	50,739	152.3
1894	347	54,729	157.7
1895	319	55,548	174.1
1896	325	60,868	187.1
1897	340	64,527	189.8
1898	348	66,468	191.0
1899	352	77,439	219.9
1900	343	80,115	248.1

From 1888 to 1900 the number of dynamos grew from 348 to 827, or to 2.4 times the former figure. Meantime, average dynamo capacity was multiplied 4.3 times, and total capacity of dynamos in lighting stations ten times. As in the case of engines, the reduction in the total number of dynamos, in spite of rapidly rising combined capacity, was largely due to the substitution of direct-connected for smaller belted units. In dynamos and engines now used to carry much the greater part of lighting and stationary motor loads, the reduction of numbers has been much greater, and the increase of average capacities more marked than the table indicates. This fact results from a practice by which, when large direct-connected units are installed, the smaller engines and dynamos formerly used are retained for occasional service.

Numbers and capacities of dynamos in private electric lighting stations:

Year of June 30.	Number of dynamos.	Total kilowatts of dynamos.	Average kilowatts of dynamos.
1888	348	6,842	19.6
1899	458	10,074	22.0
1890	635	15,244	24.0
1891	647	18,593	28.7
1892	723	21,188	29.3
1893	846	26,953	31.8
1894	659	31,749	48.2
1895	669	33,256	49.7
1896	816	40,226	49.3
1897	975	45,461	46.6
1898	892	50,490	56.6
1899	889	63,020	70.9
1900	827	68,941	83.3

An extreme illustration of this point may be noted in the case of the Boston Edison Company. For the year of 1900 this company had in its stations 38 engines and 76 dynamos. As a matter of operation, however, all except a very small part of the energy output of the company during that year was developed at one of its stations by 7 engines and 12 direct-connected dynamos. Two marked changes took place between 1888 and 1900 in the ratio of total dynamo to total engine capacities. To bring out these changes the kilowatts of total dynamo capacity in each year are reduced to horse-power by division with the factor 0.746. Comparing the horse-power capacities of engines and dynamos for the year of 1888, it seems that the latter was only 79.6 per cent. of the former.

The ratio of dynamo to engine capacity fell from the figure just named to 68.4 per cent., in 1892; from this point it rapidly rose to 115.3 per cent. in 1900. These changes have, no doubt, had an important influence on the efficiencies of electric stations. At best, dynamos must operate during quite a portion of their running time on much less than full loads, and this is especially true when few, if any, storage batteries are in use as was the case in 1888 to 1892. If dynamos at full load require only 68.4 per cent. of the rated capacities of their engines, these dynamos on their actual average loads probably require much less than one-half of the power than engines can deliver when working at their points of highest efficiency.

A result of these conditions can hardly fail to be a low efficiency of operation. The marked rise in the ratio of dynamo to engine capacities since 1892 has been mainly due to two causes: the extended use of water power with electric stations, and a better proportion of dynamo to engine ratings. Since the year just named, the proportion of dynamo to engine ratings has increased by $(115.3 - 68.4) \div 68.4 = 68$ per cent. While a part of this increase has been due to the extended application of water power, it seems that a still larger part is the result of better proportions between engines and their driven dynamos. It might be expected that the gradual substitution of large direct-connected units for belt-driven dynamos would work a reduction in the ratio of dynamo to engine numbers.

Ratio of dynamo numbers and capacity to engine numbers and capacity:

Year of June 30.	Horse-power of all dynamos.	Per cent. of dynamos to engine capacity.	Average number dynamos to each engine.
1888	9,171	79.6	2.3
1889	13,504	72.0	2.3
1890	20,434	75.1	2.5
1891	24,923	72.3	2.3
1892	28,402	68.4	2.3
1893	36,130	71.1	2.5
1894	42,558	77.7	1.9
1895	44,579	80.2	2.1
1896	53,922	88.5	2.5
1897	60,403	93.6	2.8
1898	67,680	101.8	2.5
1899	84,477	109.0	2.5
1900	92,414	115.3	2.4

The retention of old machines, however, has held the ratio of dynamos to engines between 1.9 and 2.8.

Changes in the relative capacities of arc lamps, incandescent lamps and motors that went to make up the total connected loads have been second in importance only to the combined increase of these loads. In 1888 the capacity of loads connected to electric lighting stations was 2,631 kw for arc lamps, 2,872 kw for incandescent lamps, and 614 kw for motors. Arc lamps thus represented 43 per cent., incandescent lamps 46.9 per cent., and motors 10 per cent. of the total connected capacity. In marked contrast with these figures, the total connected load for 1900 was made up as to capacity of 9.6 per cent. in arc lamps, 62.2 per cent. in incandescent lamps, and 28 per cent. in motors.

Kilowatts of connected lamps and motors in each year:

Year of June 30.	Total for arc lamps.	Total for incandescent lamps.	Total for motors.
1888	2631	2,871	614
1889	3530	4,646	1,422
1890	3999	7,735	2,723
1891	4747	10,443	5,250
1892	5638	14,577	5,485
1893	6233	17,097	6,848
1894	6640	22,937	8,944
1895	6925	26,742	10,924
1896	7485	33,435	13,930
1897	7811	40,371	16,318
1898	7938	46,159	18,930
1899	8501	52,702	22,740
1900	9342	60,175	27,133

During the twelve years in question, the total connected load grew to 15.6 times, the arc load to 3.5 times, the incandescent load to 20.9 times and the motor load to 44.1 times that at the beginning. For the year of 1900 arc lamps represented only 0.22 times, while

incandescent lamps had 1.3 times and motors 2.8 times their per cent. of total connected capacity in 1888. Between 1888 and 1900 arc lamps lost 33.4 per cent. of connected load capacity. Of this loss, incandescent lamps gained 15.3 per cent. and motors 18 per cent. of the total connected capacity. Arc lamps show an uninterrupted decline in their share of the total load capacity during the entire period. Incandescent lamp capacities either gained or held their own up to 1898, except for the year of 1891.

Per cent. of total load capacity in arc lamps, incandescent lamps and motors for each year:

Year of June 30.	Per cent. in motors.	Per cent. in arc lamps.	Per cent. incandescent lamps.
1888	10.0	43.0	46.9
1889	14.8	36.7	48.4
1890	18.8	27.6	53.5
1891	25.6	23.2	51.0
1892	21.3	21.9	56.7
1893	22.6	20.6	56.6
1894	23.2	17.2	59.5
1895	24.4	15.5	59.9
1896	25.3	13.6	60.9
1897	25.2	12.1	62.5
1898	25.9	10.8	63.2
1899	27.0	10.1	62.7
1900	28.0	9.6	62.2

Since 1898 incandescent lamps have lost 1 per cent. in their ratio to total connected capacity. In contrast with arc lamps, electric motors show a continuous rise in their per cent. of total connected capacity for every year, save 1892 and 1897. During the four years between 1888 and 1892 the ratio of arc lamps to total load capacity was reduced one-half, the like ratio for electric motors more than doubled, and incandescent lamps gained 10 per cent. on total capacity. In 1888 the capacity of connected incandescent lamps was a little greater than that of arcs, and nearly five times the capacity of motors. In 1900 arc lamps supplied less than one-sixth, and motors a little under one-half as much of the connected load as incandescent lamps.

In 1894 the capacity of incandescent lamps and motors connected to electric stations was 31,881 kw, while the total dynamo capacity was 31,749, so the connected load exceeded the generating capacity at stations by more than the 6,640 kw of arc lamps. By the middle of 1895 the connected load exceeded the dynamo capacity by more than the kilowatts of connected motors. For all except one of the five following years the sum of capacities of arc and incandescent lamps has been greater than the dynamo capacity. In 1900 the excess of connected loads over dynamo capacities was 27,709 kw. The existence of these facts brings out strongly the tendency during the decade to broaden out the loads of electrical systems over a larger part of each day.

Differences of kilowatt capacities of connected lamps and motors and the capacities of dynamos at electric stations:

Year of June 30.	Kilowatts excess of connected load.	Kilowatts excess of dynamos.
1888	.....	725
1889	.....	475
1890	.....	786
1891	1,848	...
1892	4,513	...
1893	3,225	...
1894	6,773	...
1895	11,336	...
1896	14,624	...
1897	19,040	...
1898	22,538	...
1899	20,923	...
1900	27,709	...

That there was great expansion in the amount of electrical service during the period under consideration is certain; but it is no easy matter to determine just how much the sales of electrical energy went up. Measured by total energy income, electrical service increased from a value of $1,908,394 in 1890 to $5,622,556.43 in 1900, or to 2.94 times the former amount. This increase of income, however, cannot be taken as a true measure of the rise in amount of electrical energy supplied, because, as has been shown elsewhere, there was a consiedrable decline of prices during the decade. If, on the other hand, the kilowatts of connected capacity in lamps and motors are taken as a direct measure of the energy supplied in each year, the result will be in error, because the yearly output of energy per unit of connected capacity in lamps and motors has declined during the period. Since prices for electrical energy have declined, the increase of energy sold must be greater than the increase of energy income. It follows that the sales of energy in 1900 were more than 2.94 times the like sales in 1890. The kilowatt capacity of all connected lamps and motors was 6.68 times as great in 1900 as in 1890, but the ratio of energy outputs must have been somewhat less than this number for these two years. It thus seems clear that the kilowatt-hours sold by electric lighting systems were somewhere between 2.94 times and 6.68 times as great in 1900 as they were in 1890. With constant prices per kilowatt-hour, the income per kilowatt capacity of connected lamps and motors would vary directly with the number of hours of yearly service for each connected unit at its full capacity. As prices have, in fact, been falling, the hours of yearly service for each unit of connected capacity have not decreased as fast as the income per unit of this capacity. In 1890 the energy income of electrical systems was $131.99 per unit of capacity in connected lamps and motors, but for 1900 this income fell to $58.17, or 0.44 of the like income in the former year. From this it appears that the average yearly hours of service for each kilowatt of connected capacity were more than 0.44 times as great in 1900 as in 1890.

Income from sales of electrical energy per kilowatt of capacity in connected lamps and motors:

Year of June 30.	Total energy income.	Income per kilowatt capacity.
1890	$1,908,394.00	$131.99
1891	2,432,869.15	119.01
1892	2,947,199.64	114.65
1893	3,427,576.84	113.59
1894	3,693,056.92	95.86
1895	3,794,060.41	85.08
1896	4,148,681.71	75.63
1897	4,467,146.60	69.25
1898	4,775,316.07	65.39
1899	5,046,412.75	60.11
1900	5,622,556.43	58.17

Energy income per kilowatt capacity of arc lamps, of incandescent lamps and of motors, connected to electrical supply systems:

Year of June 30.	Income for arc lamps.	Income for incandescent lamps.	Income for motors.
1896	$226.15	$57.98	$37.13
1897	224.66	52.54	36.20
1898	228.30	50.39	33.64
1899	212.68	47.64	31.98
1900	199.90	48.46	30.90

Arc lamps, incandescent lamps and motors show widely different yearly incomes per kilowatt of their connected capacities. In 1896 the $226.15 received for each kilowatt of capacity in arc lamps was 3.9 times the $57.98 received per like capacity in incandescent lamps, and 6.1 times the $37.13 received for each kilowatt of connected motors.

For the year of 1900, when one kilowatt of capacity in arc lamps earned $199.90, the same capacity in connected incandescent lamps earned $48.46, or 28.2 per cent. of the amount received from arcs, while one kilowatt of connected motor capacity brought an average income of only $30.90, or 15.4 per cent. of the income from the same capacity in arcs. The high rate of earning capacity shown for arc lamps is, no doubt, due in part to higher prices for this than for the other classes of service. A more important reason for the higher income per unit of capacity in arcs exists in their longer hours of average yearly service, compared with incandescent lamps and motors. It should be noted that arc and incandescent lamps usually operate at about full capacity when in service, while for motors this is not true. Motors usually operate more hours daily than do incandescent lamps, but during much of the time carry only fractions of their rated loads. It seems probable, however, that the hours of service for motors, reduced to terms of full rated load, would probably be as great in number as the hours for incandescent lamps. To compute the capacities of the electric lamps here considered, 60 watts are allowed for each commercial incandescent lamp, 90 watts for each incandescent street lamp and 400 watts for each arc lamp of any sort, in every year. It is believed that these factors are sufficiently near the truth to warrant the foregoing conclusions as to kilowatts of capacity in connected loads.

Thirty Years of Telegraphy and Allied Arts.

By Francis W. Jones.

The achievements of brains, capital and labor in the domain of electricity, to which subject this journal has been devoted for thirty years, would be impossible to review even as a condensed summary in a single special number of it, unless it were unduly enlarged to the proportions of a library. Such a complete review, however, is unnecessary, as the Electrical World and Engineer during this period is accessible, and its records of passing events have been very full and accurate. These records have had much more than a passive value; they have been continuously most potent aids and stimulants to its readers who were employed in the application of electricity to some useful purpose, and invaluable to teachers engaged in imparting correct information to pupils. It is only by comparison that an idea is formed of dimensions, and no doubt its review will bring into bold relief the astounding developments of the thirty pregnant years during which it has been our good fortune to live.

At the time this journal started, electricity was only utilized for telegraphy, fire alarm systems and for house bells. True, that up to 1874, sporadic attempts had been made to establish an electric light, dating back to Volta's great invention of the Voltaic battery, notably by Deleuil and Archereau in 1841, Dubosq, 1846, Staite, 1847, Cassagnes and Thiers, 1855, and last, but no least, Gramme in 1870; but at that time it had not doffed its swaddling clothes. The Electrical World and Engineer has had the privilege to record many notable inventions.

In 1874 there had been laid, in various countries, 215 cables of a total of 47,000 miles. Many were unworkable. Now there are 266,153 statute miles of working deep-sea cables, and the speed of transmission which, in 1874 was about 15 words per minute through an Atlantic cable, has now reached 47.4 words per minute over the Anglo 1894 cable 2,132 miles long, and 40 words per minute over the Commercial's 1894 cable 2,491 miles long. These number of words per minute have been more than doubled by use of the duplex upon each of the cables named; the duplex (which was introduced since 1874) being able to more than double the speed, because no switches have to be turned nor keys opened, and the readable character of the signals greatly improved by the employment of automatic transmission.

In this country, the growth of the telegraph during thirty years cannot be accurately stated. The Western Union Telegraph Company in 1874 had 175,735 miles of land wires, in addition to which were a few thousand miles of wires owned by railroads and small competing companies. In 1904 there are over 1,400,000 miles of aerial wires, not including railroads, devoted to commercial use in the United States.

In 1877 the telephone began its development, which has been phenomenal, and it has practically supplanted the telegraph in all urban communication, besides creating a tremendous business of its own, both urban and interurban, peculiar to its extreme simplicity and absence of skill in operation.

Notwithstanding the introduction of the telephone into the field of telegraphy in 1877 in this country, the mileage of telegraph wires has grown 1,200,000 miles, with an increase in ordinary telegrams of about 50 millions. Great improvement has been effected in the character and stability of poles, fixtures and wires, until now the cutting off of the principal commercial cities from each other by storms is rarely experienced, whereas, thirty years ago, it was a frequent occurrence for the telegraph company to forward large packages of delayed telegrams by train to points beyond the breaks caused by winds and sleets.

The development of Edison's quadruplex system, which is largely used, Baudot's and Delany's multiplex synchronous systems for land wires, are notable matters of record. These systems afford the present maximum traffic possibilities over a single wire, unless we except the older automatic system of Wheatstone, which has only a limited use both here and abroad. Gradual and important improvements have been made in all classes of apparatus, in wiring and switching systems.

No imagination can picture what this journal will record in 1924, on the occasion of its semi-centennial celebration or jubilee.

I have not alluded to the birth of the Edison phonograph, the first public exhibition of which I had the honor to make at 455 Madison Street, Chicago, from July 3 to 9, 1878, and then in the other largest Illinois cities; nor of the Edison incandescent lamp and the wonderful system of distribution developed at Menlo Park in 1879 and the early part of 1880. I had the honor also of being the expert employed by the syndicate of capitalists behind Edison in the early fall of 1880, to advise them if the lamp, with the carbonized cotton filament, would probably warrant them putting up money to go into competition with gas. Although my humble advice was favorable, I confess I had no dream that within twenty-four years the lamps would outnumber the stars over the entire civilized globe. Not even such a thing was foreshadowed in the then current numbers of this journal.

The Diversity of Electrical Development.

By Schuyler Skaats Wheeler.

It is not possible, in my opinion, to point out any one event of special separate importance connected with the electrical developments during the last thirty years, which is the period covered by the existence of your journal, inasmuch as so many wonderful things have been accomplished. In fact, the lifetime of your paper covers the entire electrical era.

I believe that electricity's wonderful industrial advance is particularly due to the invention and development of many different things, which though entirely dissimilar, have co-operated remarkably in stimulating the use each of the other.

The incandescent lamp, the dynamo, the constant potential system, the motor, the telephone, the telegraph, electric traction, wireless telegraphy, the turbine, the remodeling of all kinds of machinery for the use of the motor—who can say which of these has been the most important? I believe that each one has been important and that all of the others have been promoted by its success. By its drawing the public attention to the facilities of electricity, all of the others have been promoted by its success. In other words, I think that the field of electrical industries is remarkable for the extent to which inventions and successes that have nothing to do with other inventions have helped the latter by adding to the advancement of the entire field.

Our industry has one peculiarity which I think is interesting, namely, the remarkable extent to which the layman feels compelled to hold aloof from active participation in its practical work, believing that he is incapable of coping with so mysterious a subject. The fact that the industry as a whole has now become one of the leading departments of human endeavor, being one in which immense capital and millions of people are employed, makes it general and not a limited specialty, and yet all outsiders and many of those actually employed by it, feel that they can have very little to do with the practical part, a condition which I believe does not exist in any other line of work that has reached similar magnitude. On a pinch anybody will repair a steam or gas pipe. Who will repair an electric wire?

The Place of the Storage Battery in the Art.

By Charles Blizard.

In response to your kind intimation, I beg to express the opinion that the improvements embodied in the storage battery of to-day—most largely responsible for the conspicuous position it fills in the electrical field, are those which enable it to successfully withstand the high rates of discharge and to give satisfactory life and service in the hands of attendants who are not battery experts.

Without the ability to meet sudden excessive demands for power, the storage battery could not fill the requirements of several classes of application in which it is now prominent; and it would also lose much of its value as a reserve. If it could be successfully operated only by those who had especially fitted themselves for its care, its field would be comparatively limited.

Not until the storage battery had fully demonstrated that it possessed these essentials to success did its use become general. The lack of these qualities was the heaviest handicap on the storage battery of fifteen years ago.

Improvements recently made in the storage battery will further increase its life and reduce the amount of attention required.

A Review of Twenty-Five Years of Telephony.

BY ARTHUR VAUGHAN ABBOTT, C. E.

THE latter part of the nineteenth century, and the first quarter of the twentieth, may be called the "Age of Transportation," because during this period greater changes in the arts of intercommunication have occurred than during any previous epoch. These improvements have been accomplished by the aid of electricity, and this agent is further responsible for a completely new method of intercommunication which has already revolutionized modern business, and bids fair to be even a more potent factor in the future. This is the art of *selling conversational facilities* or *telephony*. The ELECTRICAL WORLD AND ENGINEER was about two and a half years old when at the Centennial Exposition of 1876, the telephone was "born." In the beginning it was regarded as a mere mechanical toy, curious perhaps, but of no practical value. To-day, in the United States, there are over three million telephone subscribers, whose daily conversations, over the wire, aggregate twenty millions, while the world numbers twice as many more. In the business of "conversation traffic" hundreds of millions are invested, tens of thousands of employees daily engaged, and thousands of companies find their sole occupation.

Like other enterprises having a scientific basis, there have been two phases of development—the engineering aspect, and the commercial one. From the engineer's standpoint the invention of the magneto telephone formed the keystone upon which all subsequent development rested, and while too much cannot be said of the genius of Professor Graham Bell in solving the problem of the electrical transmission of speech, many other inventions were necessary to render the telephonic systems of to-day possibilities. While the magneto proved itself so efficient a receiver that the original model survives, it failed as a transmitter, and the second step was the invention of the carbon battery transmitter of Edison and others. In this electricians broke away from the idea of utilizing the feeble energy of vocal sound waves as the source of power, and supplied the transmitter with a battery, capable of furnishing energy, employing the sound waves simply to actuate a releasing mechanism to regulate the battery discharge. The use of a battery necessitated some means whereby its circuit could be closed and opened whenever the telephone was placed in, or out of service. To rely upon a manual switch, dependent on the fallible memory of the subscriber, was impractical and the invention of the *"hook switch"* made the commercial use of the battery transmitter possible.

The next problem was a sub-station signal, for at best the voice of the receiver was too feeble to attract attention. Batteries and vibrating bells gave no end of bother, but the *"magneto bell"* and *"hand generator"* have proved so satisfactory a solution that no one proposes a better. Growing demand showed electricians that the time was at hand when the lines of many users must be concentrated at a single point. How to quickly and surely interconnect various wires became the next question, which was answered by the invention of the *"spring jack."* From time to time improvements in methods of jack manufacture, or economy of space, have arisen, but the jack as a piece of apparatus has survived unchanged, nor does it seem that the near future will offer any substitute.

Soon it became impractical to place before a single attendant a sufficient number of jacks to care for all lines of even a small territory, so section after section of switchboard was required. To connect the wires in one with those of another, local circuits were devised, but this rendered operating slow and cumbersome. The invention of the *"multiple switchboard,"* whereby the line of every subscriber is carried through a multiplicity of jacks so that each attendant can reach the line of every one, marked a vital advance.

For the first decade, the wire plant consisted solely of aerial grounded lines of iron wire, but its objectionable magnetic characteristics, together with rapidly increasing introduction of other electrical industries made it imperative to improve the conducting system. First came the invention *"hard drawn copper wire,"* rendering it possible to build open wire lines of much better conductivity, having no objectionable magnetic characteristics; and the substitution of the complete *"metallic circuit"* removed inductive difficulties. Then came the *"paper cable"* into whose leaden embrace two or three hundred circuits can be packed in a space of four or five square inches, and as a sequence the *"underground conduit."*

To economize installation expense several stations were connected to a single line, but transmission limits were soon reached, as it was impossible to talk through the impedance of the bell magnets. The *"bridging bell"* wound to give too great an impedance to sensibly divert the high frequencies of voice currents, enabled ringers to be placed as shunts and made the *"party line"* a success.

For many years, at the central office, the old-fashioned drop reigned supreme as the subscriber's signal, but presently the demand for quicker service required a means more salient, and completely automatic, and the *"incandescent lamp"* and *"bridging board"* replaced the old series multiple. The local battery presented a stupendous problem. In Greater New York upwards of a hundred thousands stations exist. Consider the task of making eight hundred thousand or a million battery renewals per annum in one city. The solution was the *"common battery"* system, whereby each central office supplies electricity for all subscribers.

With the growth of the art came the demand to talk over greater distances. Boston must speak to Chicago and San Francisco; New York desires to talk with London, but the electrical characteristics of even the most heavily coppered aerial lines place the barrier to commercial transmission at about 1,000 miles of open wire, while but a fraction of this distance through submarine cable is practical. To the electrical engineer there is no such word as "fail," and the *"loaded line"* in which objectionable inductance is made to counterbalance and neutralize equally destructive capacity, has produced a circuit whereby even trans-oceanic telephony seems within grasp.

Turning from the engineering to the business aspect, the sagacity which has constructed the present telephone system is equally wonderful. The fundamental patents of the magneto telephone were secured by the original Bell Telephone Company, which through various organizational permutations and combinations has been known successively as the American Bell Telephone Company and the American Telephone and Telegraph Company. The original policy was to control the manufacture of telephonic apparatus, and to rent the same to those who desired to use it. So the parent company succeeded in building up in nearly all our cities and in many European ones, operating corporations whose business it was to *sell service*. As to the policy pursued there may be many, and very honest differences of opinion; to err is human. It would be impossible to expect such an organization to conduct for a quarter of a century its business to the liking of every one, but, however, much one may disagree with many of the methods adopted, no one can fail to admire the skill and tact which conceived and executed

The Telephone.

THE proprietors of the Telephone, the invention of Alexander Graham Bell, for which patents have been issued by the United States and Great Britain, are now prepared to furnish Telephones for the transmission of articulate speech through instruments not more than twenty miles apart. Conversation can be easily carried on after slight practice and with the occasional repetition of a word or sentence. On first listening to the Telephone, though the sound is perfectly audible, the articulation seems to be indistinct; but after a few trials the ear becomes accustomed to the peculiar sound and finds little difficulty in understanding the words.

The Telephone should be set in a quiet place, where there is no noise which would interrupt ordinary conversation.

The advantages of the Telephone over the Telegraph for local business are

1st. That no skilled operator is required, but direct communication may be had by speech without the intervention of a third person.

2d. That the communication is much more rapid, the average number of words transmitted a minute by Morse Sounder being from fifteen to twenty, by Telephone from one to two hundred.

3d. That no expense is required either for its operation, maintenance, or repair. It needs no battery, and has no complicated machinery. It is unsurpassed for economy and simplicity.

The Terms for leasing two Telephones for social purposes connecting a dwelling-house with any other building will be $20 a year, for business purposes $40 a year, payable semiannually in advance, with the cost of expressage from Boston, New York, Cincinnati, Chicago, St. Louis, or San Francisco. The instruments will be kept in good working order by the lessors, free of expense, except from injuries resulting from great carelessness.

Several Telephones can be placed on the same line at an additional rental of $10 for each instrument; but the use of more than two on the same line where privacy is required is not advised. Any person within ordinary hearing distance can hear the voice calling through the Telephone. If a louder call is required one can be furnished for $5.

Telegraph lines will be constructed by the proprietors if desired. The price will vary from $100 to $150 a mile; any good mechanic can construct a line; No. 9 wire costs 8½ cents a pound, 320 pounds to the mile; 34 insulators at 25 cents each; the price of poles and setting varies in every locality; stringing wire $5 per mile; sundries $10 per mile.

Parties leasing the Telephones incur no expense beyond the annual rental and the repair of the line wire. On the following pages are extracts from the Press and other sources relating to the Telephone.

GARDINER G. HUBBARD.

CAMBRIDGE, MASS., May, 1877.

For further information and orders address

THOS. A. WATSON, 109 COURT ST., BOSTON.

FIRST CIRCULAR EVER ISSUED FOR TELEPHONE BUSINESS.
(Reduced Fac Simile of Original in Possession of T. C. Martin.)

the plan that successfully welded together hundreds of diverse organizations.

It was natural at the outset to adopt the plan of renting telephonic instruments, and if the early idea of only leasing them had been adhered to, allowing those who obtain them to serve themselves, the flat rate charge would be legitimate. But telephone companies became operators. They not only manufactured apparatus but furnished service, so now the supply of apparatus is but a small portion of the real business. What the telephone company offers is the transportation of intelligence. To charge each subscriber $50 per year for a telephone is as absurd as for a railway company to charge each of its freight customers $1,000 per year for a locomotive. One of the most significant steps in telephonic policy is the adoption of "measured service," whereby the subscriber is billed at a certain rate for every message transmitted. To-day the unit of charge is the call. That this is more equitable than any flat rate system is obvious, but it is equally plain that the call is not a true unit. It is unfair to charge a man who talks ten minutes the same price as one who talks one. It is equally unfair to charge one customer the same rate for a message transmitted one mile as is made to another who talks ten miles. Toll service early recognized this fallacy and toll charges are based both upon mileage and time. While to adopt a similar system for ordinary city exchanges may tax the ingenuity of the auditor, it is a reform which sooner or later will appear.

Half a dozen years ago the fundamental patents expired, and the field became open to all. Stimulated by the success of telephony, hosts of inventors and investors hastened to avail themselves of the opportunity. Naturally all who had from time to time disagreed with the policy of the older company arrayed themselves upon the other side; some thousands of "Independent" organizations have appeared, and several hundred "Independent" manufacturers of apparatus are at work. Within a decade the number of telephonic subscribers have been quintupled, of which the "Independents" claim about half.

What of the future? First and foremost is the certainty that the enormous growth of the past will continue, though probably at a decreasing rate. In the United States there are upwards of twenty million families, and at least five million places of business, making a total of twenty-five million opportunities to install telephones. Of these about one-eighth are now equipped; the others must be provided for, and it will tax the resources of manufacturers, operators and financiers to do it.

During early telephonic days the art was entirely experimental. It was necessary to expend millions of dollars in learning how telephone exchanges should be built. To-day many of lessons have been learned, apparatus is rapidly becaming standardized, telephonic engineers know what and how to construct. Consequently, annual allowances for maintenance and depreciation can be reduced, with a corresponding decrease in the cost of service. Improvements in manufacturing methods cheapen apparatus with a similar result, and as the price for telephonic intercommunication falls, the zone over which telephones may be distributed extends. As more and more people obtain telephones, the telephonic habit grows, for traffic breeds traffic. To-day no business house can afford to be without a telephone and shortly no residence can, so he who runs may read the prophecy for the future.

A significant tendency is the adoption of mechanical appliances in the operating room. The lamp signal removed the manual drop. Machine ringing has relegated the manual ringing key to the scrap heap; self-ejecting plugs are possibilities, and many inventors have proposed, and with some degree of success, operatorless exchanges. In a general way the tendency of the telephone company is to relieve the subscriber of all work and to concentrate every function in the exchange. This appears incompatible with the automatic switchboard, which necessarily must inflict a greater burden upon the subscriber. But the automatic exchange may, and probably will, have a certain and very wide field. To expect the business man to operate a series of levers, or dials to call a subscriber, when he can pick up a receiver and tell his private exchange operator just what he wants, is folly. It is equally foolish to require the Chinese laundry, the corner grocery and the tenement house to pay the rate required by the service needed on Wall street or Broadway. It appears quite possible that some form of automatic exchange may be devised, which will be installed in certain zones of the larger cities, and be entirely adequate for the smaller towns and villages. Such automatic exchanges will work in conjunction with manual exchanges in such a manner that service may be graded to fit the customers to which it is addressed. This is as logical a proposition as for a railway to run Pullman cars, day coaches and immigrant trains. But it would be equally illogical to force all passengers into one train. The service must fit the customer.

The field of the telephone is by no means exhausted. The Electrical World and Engineer has suggested the telephonic transmission of money orders; witnesses are examined and depositions taken telephonically; it is veraciously reported that several engagements and some marriages have thus been consummated; but so far there have been no divorces and no executions by it; so there are yet many opportunities to develop the business in ways perhaps now unexpected.

A keen competition is often regarded as a business blessing; and, so far, telephonic competition has been by no means an unmixed evil. But telephony differs from other commercial undertakings. Usually a wholesale business is cheaper per unit than a retail one, but such is not the case in telephony, for the cost per subscriber in a 10,000 line exchange is greater than in one of 1,000 subscribers. It would not be considered desirable to have two rival post offices, and telephonic service resembles postal service. If there are two telephone companies in one city, either both must interchange messages, or else the subscribers, to get complete facilities, must have two telephones. If the latter, installation costs are doubled, for there are twice as many sub-station instruments, and twice as much wire plant. Hence the cost of service is augmented, for in the end the community pays all the costs and all the profits of running two companies. What shall the solution be? Is it to be municipal or governmental operation like the post office? Will legislation force all telephone companies to interchange all messages? Shall a Utopian state of affairs arise in which one company will so adjust rates as to pay reasonable operating expenses, legal interest on unwatered capital, and no more? or may some form of co-operative ownership be devised in which each subscriber is a stockholder and annually receives any surplus over operating expense? *Quien Sabe.*

The Evolution of the Enclosed Arc Lamp.

By L. B. Marks.

The enclosed arc lamp of commerce dates from the year 1894. For fifteen years prior to that time the open arc held sway. A glance at the arc lamp statistics shows that there was a sudden turning point in the evolution of the arc lamp. The enclosed arc, as if by magic, ousted its predecessor and gave a remarkable impetus to the introduction of arcs, particularly on constant potential circuits.

The question has often been asked, "What was it that brought about this sudden introduction of the enclosed arc lamp?" Was there any new discovery or invention that made possible what formerly had not been accomplished? Surely a host of inventors, both in the United States and abroad, had experimented with the enclosed globe arc lamps ever since the earliest days of arc lighting. The records of the Patent Office will attest this fact. There are some who think that the enclosed arc lamp is simply an outgrowth of the development of carbons—that if we had had a satisfactory carbon in the early days of arc lighting, the open arc would never have held sway so long.

Now, as a matter of fact, satisfactory carbons were on the market continuously for many years prior to the advent of the modern enclosed arc lamp. The price of these carbons was naturally higher than it is now, but not prohibitively high. In some of my work in arc lighting years before the first commercial enclosed arc made its appearance I employed very pure carbons that were admirably suited for use in the modern enclosed lamp. These carbons were manufactured in this country and were sold at a price not exceeding the present price of good imported carbons.

Those who are familiar with the steps in the evolution of the enclosed arc lamp of commerce know that this type of lamp was made possible by the discovery that when an arc is enclosed in a small globe having suitably restricted air inlet, a long arc of abnormal voltage may be steadily maintained by a small current—a condition impossible in free or open arcs. This discovery was followed up by the construction of a lamp that would strike a long arc and maintain it under the proper conditions. Herein, then, lay the secret of the modern enclosed arc lamp. Broadly speaking, that secret was

not in the carbon, but in the arc. The solution of the problem, therefore, involved, first, a method of operation, and, second, an apparatus for carrying out that method. So far as the records go, neither the method nor the apparatus was known to the world prior to the year 1893. Once these features were given to the art, the commercial enclosed arc lamp became an accomplished fact.

The First Commercial Electric Street Railway in America.

WHAT a marvelously brief period has sufficed to establish electrical power in full possession of the field of urban passenger traffic, receives a striking illustration in the fact that to a man, to-day but in his fortieth year, belongs the honor of having personally guided the first electric motor for street traffic put in practical commercial service in this country.

The event which marked an epoch in the solution of the problem of the application of electricity to the purposes of passenger traction occurred in the city of Baltimore and the man who stood at the controller of the first practical electric locomotive taking its power from the now familiar third rail, was Guy M. Gest, now a prominent electric subway contractor of New York and Cincinnati, who prizes above all other honors he has won in a career devoted to the development of electric subway work, his undisputed right to the title of "The Father of Motormen," who in spite of his youth now numbers his "sons" by the hundred thousands. The very name "motorman," now so convenient and familiar, had not yet been

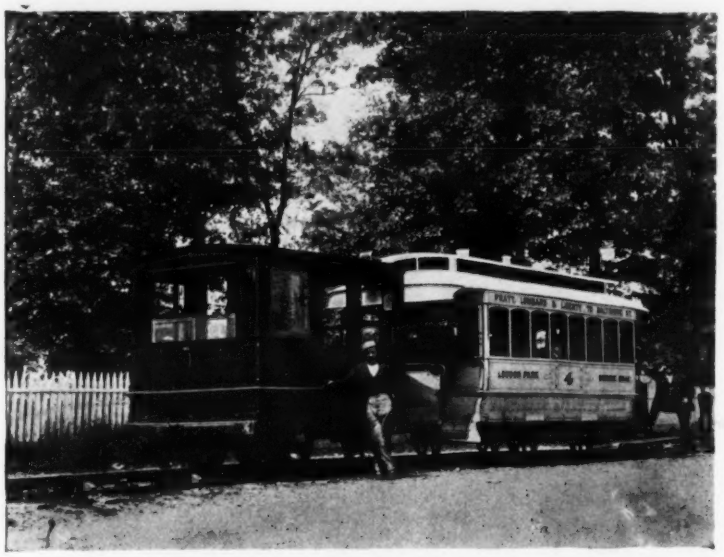


FIG. 1.—DAFT ELECTRIC STREET RAILWAY LOCOMOTIVE.

invented when Mr. Gest piloted the first train of electrically-propelled cars through the streets of Baltimore, his function on that historic occasion being described in the newspapers of the day as that of "engineer."

In connection with this historical performance it is interesting to note that the third rail from which the car derived its power, while laid on the surface between the wheel tracks was so protected from any accidental external contact as to make it practically identical in principle with the modern conduit system supplanting in urban practice the overhead trolley wire, which was the immediate successor of the original third-rail device, thus offering another example of the familiar tendency to a reversion to first principles.

To Mr. Thomas C. Robbins, General Manager of the Union Passenger Railway of Baltimore, belongs the credit of having first recognized the possibility of the successful application of electricity to the solution of the problem of street car propulsion and it seems to have been peculiarly appropriate that the practical demonstration of the correctness of Mr. Robbins' judgment should have been made in the same city which witnessed the first practical test of telegraphy, on May 1, 1841, just forty years earlier. It is also appropriate that the first practical electric motor should have borne the illustrious name of "Morse," the inventor of the electric telegraph.

Electric traction had not yet emerged from the stage of experiment when Mr. Robbins cast about for some efficient substitute for horse power in the operation of his lines and his attention was first called to the startling possibilities of electricity by the performance of a lilliputian exhibition railroad that formed one of the amusement features of Coney Island in the summer of 1884. He consulted with Mr. Daft, the inventor for the Daft Electric Company, of Greenville, N. J., who went to Baltimore, and after a careful examination of the road, declared that there could be no question

FIG. 2.—WYETH SWITCH, DAFT THIRD-RAIL ROAD, BALTIMORE.

of the entire practicability of Mr. Robbins' plan. A contract for the installation of a power plant and the construction of motors was at once entered into, and while two motors were under construction in the shops of the Daft Electric Company at Greenville, under the supervision of Mr. G. W. Mansfield, a power house was erected, adjoining the car stables, equipped with a 75-hp engine and a 50-hp dynamo. The preparation of the track and the laying of the protected third rail and wire connections were undertaken under the direct personal supervision of Mr. H. A. Foster, of the Daft Company. How well the whole work of construction and equipment was performed was fully attested by the complete success, not only of the first trials, but of the subsequent operation of the road. Simultaneously with the completion of the power-house and the track the Daft Company was ready to put into service the pioneer motor, or car, as it was more usually termed in those days, the "Morse" and its companion the "Benjamin Franklin."

There is a quaint flavor of simplicity attaching to the description of this historic machine published in the *Morning Herald* of Baltimore of August 10, 1885, which makes it well worthy of reproduction. Referring to the wonderful "electric engine" the reporter who attended the trial writes: "This is a plain little caboose,

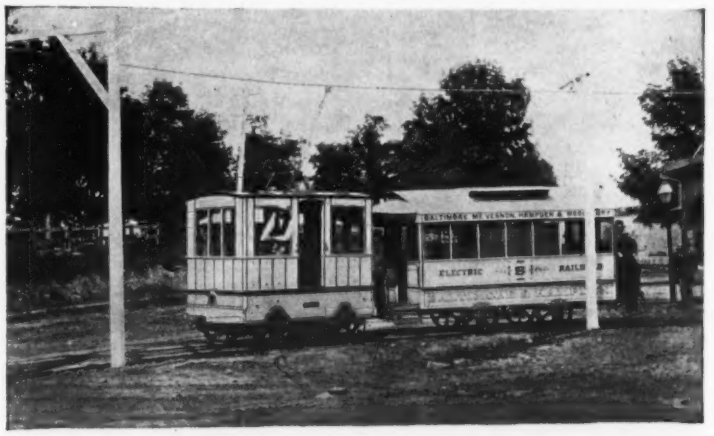


FIG. 3.—DAFT UNDERRUNNING TROLLEY, BALTIMORE, MD.

weighing, with armature, only 4,500 pounds. It is about 8 ft. long and 4 ft. wide and the roof is only 9 ft. from the ground. From the center of this motor, which has been named the 'Morse,' hangs a little brass wheel called the 'contact wheel.' It runs entirely on the center rail, taking up the current of electricity and conveying it into the armature in the forward end of the motor. The current of electricity is administered to the center rail from the dynamo generator in the engine-house by means of copper wires. When

the contact wheel takes it up from the center rail the armature at once becomes 'excited' and the motive power is transmitted to the axle by means of gearing, and the wheels of the motor are thus thrown into motion. Through the outside wheels the current is then returned to the dynamo generator, thus keeping up a continuous current along the entire length of the road." With the view of reassuring the good people of Baltimore against any suggestion of danger from the mysterious new power the reporter continues: "The electric current is low-tension and no danger of shock will result to man or beast if the rails are touched in crossing or with the bare hands. In the latter case the result is only a slight tingling sensation."

The "Morse" was equipped with a compound series motor rated at only 8 hp, with single-reduction gears; regulated by a primitive form of controller. She was shipped from the shops of the Daft Company at Greenville on June 10, reaching Baltimore two days later, and so advanced were the preparations at the power-house that it was possible to conduct the first private trial of the new motor on the following day, the result giving every augury of the complete ultimate success of the plan. Various details, inseparable from the launching of a pioneer enterprise, remained, however, to be adjusted, and it was not until August 9, at one o'clock a. m., that time being selected in order to avoid popular excitement that would have attended the first appearance of the motor, that the first actual trip over the line was made, under conditions that only varied from those of actual practical service in the fact that the passengers carried, twenty-nine in all, were confined to officials of the railroad and of the construction company and to representatives of the press.

One of the pictures herewith illustrates what must be regarded as one of the earliest and most interesting attempts to use an overhead trolley contact as an alternative to the third rail and as a means of getting by crossings. At one side of the track a series of brackets were erected on poles, the arms being of pine 3 x 4. From these gas pipe was suspended by means of a U-shaped insulator. The contact brush to this overhead trolley consisted of a laminated series of sheet iron, some 6 x 8 in. wide clamped together and fastened to a wood trolley pole, the base of which was connected by an ingenious toggle arrangement to a lever in the inside of the cab, permitting the motorman to raise and keep in contact the brush when passing over the street crossing at which point this interesting and really first demonstration of such an underrunning trolley was used. The motorman by a foot lever raised the third-rail contact wheel and with his left hand controlled the overhead attachment and thus maintained a continuous contact. This arrangement was not added to the original method of third-rail contact until the road had been in operation many months, its necessity was urged on account of animals being injured by coming in contact with the third rail at street crossings. The details of this device were handled by Mr. A. H. Haywood, who took up the Daft Company's interests in Baltimore after Mr. H. A. Foster severed his connection with that company.

The train was made up of the "Morse" attached to one of the ordinary passenger cars. Mr. Gest, who had been identified with every detail of the construction of the motor, stood at the controller and at a signal from Mr. Robbins turned on the power and set in motion this pioneer of third-rail electric trains. The report of the *Morning Herald* tells us: "A brilliant flash of light shot out into the darkness as the contact-wheel fell upon the center rail and a shower of sparks flew right and left and then the motor, dragging the passenger car with its living freight, rolled rapidly out of the yard and sped on its way. A few hundred yards were traversed and then the current was cut off, the brake applied and the train returned to the yard up a steep incline. Back and forth the motor ran again and again, and each time it ran over the rails it improved in its action. Once it ran off the track, owing to a misplaced switch, but it was quickly replaced. Afterwards the passenger car was detached and the motor was run at a rapid rate of speed around curves and over switches with the greatest ease and safety. The trial was a most thorough and satisfactory one, as was testified to by all, and with the exception of a few minor mechanical defects, which can soon be adjusted, the trial perfectly demonstrated the practicability of the motor." It was estimated that the use of electricity would be attended with a saving of over 50 per cent. over that of horses. Later, two other and larger electric locomotives were installed on the road. The average daily run of each was 75 miles.

The attention of the street car companies of New York, Boston, Chicago and Philadelphia and of all the great cities in Europe had been riveted on this epoch-making trial in Baltimore and its triumphant success gave everywhere a tremendous stimulus to the substitution of electricity for horse or cable power. Less than twenty years have sufficed to fulfill the prediction, made by Mr. Robbins and Mr. Foster at the conclusion of the trial, that its success marked the beginning of a revolution in street car propulsion as complete as that wrought in stage-coach traffic by the appearance of Stephenson's locomotive; and to-day, having completely conquered the domain of city and suburban traction, the mighty successors of the little "Morse," driven by Mr. Gest, are threatening to relegate the descendants of the "Rocket" to the limbo of the stage-coach and the horse car.

Speaking recently of the wonderful development of electric subways with a fellow member at the Union League Club, Mr. Gest said: "I was little more than a lad, just about old enough to vote, when I assisted in that almost-forgotten trial of the first electric motor in Baltimore. To my mind it marked the beginning of the era of the successful application of electricity to locomotion and as such the event is worthy of commemoration. I take a keen satisfaction in the fact that I bore a part in it, and as I look back to that small beginning I am astonished at the progress that these comparatively few years have brought about. It should not be forgotten that a very substantial share of the credit for the success that attended the electrifying of the Baltimore road was due to the skill and energy of Mr. H. A. Foster, whose admirable ideas in carrying out the work of construction of the power plant and the track arrangements showed him to be the accomplished electrical engineer that he is. From the beginning, however, none of us who were associated in the work had the least doubt of its complete success, although it is easy to see how, in that early stage of electrical science, there were many unforeseen difficulties to be met and overcome. I do not know whether the old 'Morse' on which I officiated as motorman is still in existence, but if she is I think that a place should be found for her in the National Museum beside the earliest locomotive. Although she took her power from a primitive form of third-rail her performance fully demonstrated the practicability of the electric railway system.

"And apropos of that," continued Mr. Gest, "I am reminded how universally visitors to New York express wonder when they see one of the old horse-cars crawling along one of the side streets downtown. Of course, the reason for keeping these old cars in service is obvious in the economic objections which stand in the way of laying down subway conduits under the conditions that prevail in many parts of the city, but the change is bound to come and sooner or later. With the disappearance of the last horse-car our country cousins will have one less metropolitan wonder to talk about when they go home. I had an amusing illustration of this the other day when I brought my son, a youngster of seven, to New York on a visit. About the first thing that attracted his attention after leaving the ferry was one of the old cars on West Street. He stopped in open-mouthed wonder, for he had only seen horse-cars in pictures, and was only satisfied when I promised that some day I would take him for a ride in one. I thought to myself, 'surely that the world do move' when the son of the man who drove the first electric street motor is curious to enjoy the novel experience of a ride on a horse-car. I shall have to hurry up, before the last car is gone, if I want to keep my word with the little lad."

A Period of Great Development.

BY FRANCIS BLAKE.

In reply to your letter of invitation, I have to say that I am much impressed by the fact that the life of your journal covers the period of the birth and a marvellous development of the science which governs the commercial use of electricity.

If I were asked for specific reasons for this general statement, I should refer my questioner to the volumes of the ELECTRICAL WORLD AND ENGINEER which—by their advertisements as well as by their leading articles and their editorial matter—present a most valuable record of this important epoch in the world's progress.

Upon the occasion of your thirtieth anniversary, I congratulate you upon the fidelity and the ability with which your journal has rendered its technical services to the electrical fraternity in particular and to humanity in general.

The Electric Railway Industry in 1883.

BY FRANK B. RAE.

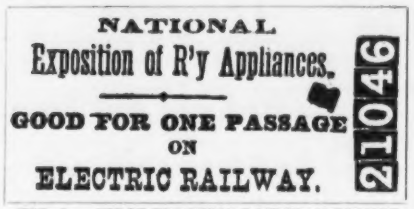


FIG. 1.—FIRST ELECTRIC RAILWAY TICKET.

THE early days of the electric railway business were all twenty-six hours long and loaded with trouble. Motors were puny things in the early eighties. It was necessary to sit up with them nights and give them homœopathic doses of shellac in various parts of their anatomy, tie up the sore places with tape, and devise schemes to hold the armature leads and the commutator bars together for the next day's run.

The things we did not know back in '83, put in book form, would make a Carnegie library look like an elevated railway book stall. This should perhaps be qualified by saying, the things that some of us did not know, etc. There were those who knew all about everything; moreover, they wrote about it in the papers, whereat we of the working force marvelled. Some of these things, re-read to-day, would make most anyone marvel; but one of the real scientific facts that some chap wrote at the Philadelphia Exposition in '84 looms up like the shadow of a great rock in a desert, and has been a daily help and guide. He said: "A dynamo machine may be painted any color without affecting its efficiency." This is as true to-day as when it was written, twenty years ago, which is more than can be said of some of the other stuff.

The first electric railway company in this country, organized to construct and equip electric roads, was, I believe, the Electric Railway Company of the United States, with offices in the Mills Building, New York. This company acquired, or expected to acquire, the railway patents of Thos. A. Edison and Stephen D. Field. It

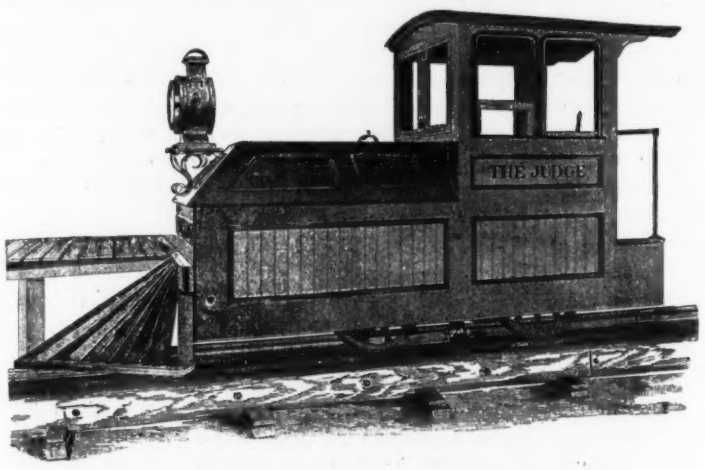


FIG. 2.—THE FIELD ELECTRIC LOCOMOTIVE "THE JUDGE."

was backed by Cyrus W. Field and his associates, with Mr. S. G. Reed, president, C. W. Rogers, vice-president, and Chas. Dimon, secretary and treasurer. Rogers was the active man, and his activity was of the brand that "eboluted" a lot but resulted mostly in hot air. He traveled in a stateroom with a typewriter and a hard-working young chap that was referred to frequently as "my secretary." Letters were mailed at every stop, and confirmed by telegraph. The end came before any real business happened, probably due to the preliminary funds having been used up in postage and telegraph tolls. The company did, however, equip one road, not a very long one, it is true, but it was as broad as some of them, and has the distinction of being the first electric road for business purposes in the United States. One night in March or April of 1883, there was a meeting at the Fifth Avenue Hotel, attended by Edison, Field, Prof. Morton, the engineer of the Northern Pacific road, and myself, the last three being a committee appointed to pass upon the Edison and Field patents, and determine their value to the Electric Railway Company of the United States. After it was over, Field said: "Frank, I wish you would go to Chicago to-morrow, and build an electric road for the Exhibition of Railway Appliances. I have had shipped there two Weston 100 incandescent light dynamos; use one as a generator and the other as a motor. You will find the track down around the gallery of the building, and Mr. J. McGregor Adams will give you any assistance you require." When more details as to construction were insisted upon, Field covered a sheet of paper with drawings and said: "There, put your motor crosswise on a truck, extend the shaft, use a bevel gear to drive a counter-shaft, put some pulleys on the counter-shaft, and belt to some others on the truck axle. Make a rig to reverse the brushes to reverse the armature, and—there you are."

All this was done, and several other things, before "The Judge," as the machine was called, was ready for service; and this brings us back to the remark above, about things we didn't know in 1883. At least, we didn't know them right off quick. For instance, it required something like twenty-four hours, mostly spent walking along the lake front, to grasp the fact that a shunt-wound dynamo, built as only Weston knew how at that date, would not generate current when started up on a short circuit, *because it couldn't*. It would not do, of course, to throw the shunt-wound motor on to the dynamo after the dynamo started and was up to voltage, so it was provided that the motor should start up with the generator and run continuously, the load being thrown on with a friction clutch on the axle. But the motor refused to start up with the generator, hence the ramble

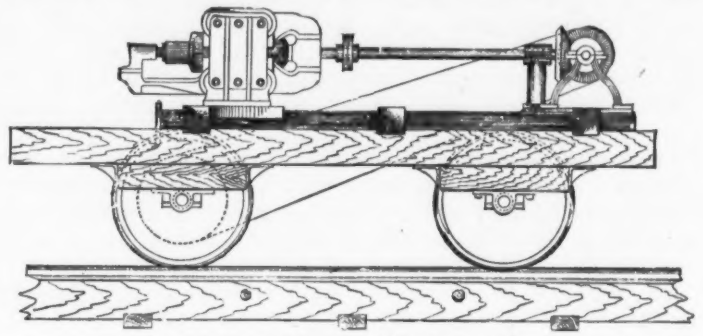


FIG. 3.—DETAILS OF "THE JUDGE."

along the lake front, resulting in making a resistance for the armature circuit of the motor and a switch to gradually cut it out. It is quite possible the board of underwriters would not pass this particular style of starting rheostat to-day. It was constructed of bare soft iron wire wound in grooves, planed into some pine boards, which boards were set on fire four or five times a day, with a regularity that would have been greatly missed, if a modern iron-clad rheostat had been substituted.

This road was a third-rail road bonded with No. 6 copper and had a total circular length of 1,553 feet. The locomotive, Figs. 2 and 3, hauled one car, seating 20 people, and in the ten or twelve days of operation, 26,805 passengers were carried, and $2,680 was earned. All this was comparatively easy; the days of trouble came a few years later, but that's another story.

I believe that the electric railway ticket here shown in Fig. 1 was the first ever printed and issued specifically for electric railway purposes.

Telephony the Greatest Invention of All.

BY P. B. DELANY.

This paper now and what it was thirty years ago is graphically illustrative of the progress made in electrical science and invention.

To my mind, the greatest invention within, or without this span, is the telephone. The electric light is a priceless boon, the trolley a great utility, wireless telegraphy a wonderful achievement; but the telephone is all these and a blessed benefaction in human affairs as well. Its sublime simplicity and marvelous adaptability, transcend all comparisons in the domain of pure or applied science.

The extension of audible speech transmission from a stone's throw to a thousand miles, and with quieter inflection, is a work unrivaled. The telephone is an allayer of worry, an assuager of sorrow, a life saver, a deterrent of crime, an earnest of security, and an indispensable commercial necessity. The world could better afford to go back to the "penny dip" and the stage coach, than give up the telephone.

As to what the future holds, no man may say; but even though he explores the ambient clouds on a radium motor, with a searchlight for a rudder, the telephone invention will still be secure in its peerless position.

The First Central Station for Incandescent Lighting.

By W. J. Hammer.

SOME years ago while preparing a lecture on Edison's life and his inventions, which I delivered before the Franklin Institute, I asked Mr. Edison what he considered his most important achievement, and he replied without hesitation, "The Jumbo dynamo." Those who are familiar with the early days of electric lighting will remember that prior to the construction of these huge Edison machines there were practically no dynamo machines in existence which could not be lifted and carried around by two or three men, and it was a tremendous step forward from the small machines then generally constructed to the mammoth Edison dynamo, which weighed 23 tons and employed a bar armature weighing 4½ tons.

Those who are familiar with the experimental work at Menlo Park on the Edison bar armature machine and the subsequent construction and testing of the first "Jumbo" machine which was sent to the Paris Electrical Exposition of 1881, will understand and remember the number of times which this machine was taken apart and put together again at the old Goerck Street Machine Works. Those who participated in the sleepless days and nights at that period of great anxiety will understand why Mr. Edison has attached such importance to the construction of this huge dynamo.

I well remember having been entrusted with the loading of this Paris Exposition machine on the gigantic "Ox," the only derrick in New York Harbor which could handle it, and lying all night alongside of the steamer on the North River; and I remember also the difficulty I had in securing the shipment of this machine, which necessitated the risky carrying of the 4½-ton armature upon the deck.

The second and third "Jumbo" machines were sent to England and were installed by Mr. Edward H. Johnson and myself in the 3,000-light central station on Holborn Viaduct, London—this constituting the first central station for incandescent lighting in the world, it having been started on January 12, 1882; whereas the Pearl Street station in New York, the first one established in this country, did not start until September of the same year.

It is probably known to very few where the term "Jumbo" dynamo originated, and I can claim the honor of giving this type of machine this name—and it came about in this way: The two dynamos which were sent to England were despatched on the "Assyrian Monarch," of the Monarch Line, this being the same steamer which had just before that carried the celebrated elephant, Jumbo, which the American showman, Barnum, had purchased from the London Zoological Society, and it occurred to me to dub the first machine "Jumbo" and the second one "Alice," after Jumbo's mate in London; and the name "Jumbo" has ever since characterized this type of machine.

It is interesting to call attention to the fact that this Edison dynamo was the first direct-connected generator. One of those which were sent to London had its armature directly coupled to a Porter-Allen engine and the other to an Armington-Sims engine. I had the honor of first coupling up two of these machines and making one run the other as a motor; and in April, 1882, the two machines which had been alternately used were run together successfully in multiple or parallel, this being the first time that these machines were so coupled. A cablegram was sent to Mr. Edison by Mr. Johnson announcing the success of this test, and subsequently not only two, but three of these machines were run in parallel. There are many who will remember the great difficulties which were subsequently met at the Pearl Street station when efforts were made to run the "Jumbo" machines there in parallel.

The history of the first central station for incandescent lighting established in the world, namely, the 3,000-light Holborn Viaduct station, started January 12, 1882, has never been written. The present occasion offers neither the time nor space to present this matter properly, but I should like to call attention briefly to a few important features connected with this historic plant, which was originally intended as a European demonstration of what Mr. Edison's electric lighting system was, and which was operated long after the time originally proposed. The station had been erected on property belonging to the Crown, and it was impossible to construct the large station subsequently planned. That, together with other electric lighting enterprises, were knocked in the head by the celebrated Electric Lighting Act of 1882, which caused financiers contemplating investments in electrical enterprises to button up their pockets until Parliament should deal with the industry in a more liberal spirit.

It may interest many to know that this station supplied its consumers by a network of feeders and mains of the standard underground two-wire Edison tubing, such as was subsequently used for a long time in New York City, Milan, Italy, and elsewhere. It used a meter system employing the well-known Edison electrolytic meter. Arc lamps were run from these circuits, and I assisted Dr. John Hopkinson in experimenting with Siemens' differential arc lamps, specially constructed for this purpose. I also assisted Dr. Hopkinson in his experiments with his mechanical meter employed experimentally on these circuits; and one of the first sets of "Faure" batteries sent to England was experimentally used at the Holborn Viaduct station.

In connection with this set of "Faure" batteries an interesting incident occurs to me. A small boy passing through the station, whistling a tune and swinging carelessly a hammer carried in his hand, rapped a carboy of sulphuric acid which happened to be on the floor above a "Jumbo" dynamo. The blow broke the glass carboy and allowed the acid to run down upon the field magnets of the dynamo, destroying the windings of one of the 12 magnets, which formed the pole pieces of this machine. This accident happened during a vacation I was taking in Germany, and a prominent scientific man connected with the company cabled Mr. Edison to know whether the machine would work if this coil was cut, and Mr. Edison made the laconic remark, "Why don't he try it and see?" I remember about this period assisting Sir William H. Preece in a lecture before the Society of Arts in which an Edison bipolar machine was dropped off a truck and the winding of one leg of the magnet sot badly cut that I was forced to use the machine with only one leg connected, but it worked with perfect satisfaction, although the machine had to be placed on the Thames embankment a long distance away and controlled from the lecture stage.

Up to the time of the construction of this plant it had been customary to place a single pole switch on one wire and a safety fuse on the other, and the practice of putting fuses on both sides of a circuit was first used here. Some of the first, if not the very first, of the insulated fixtures were used in this plant, and many of the fixtures were equipped with ball insulating joints, enabling the chandeliers or electroliers to be turned around, as was common with the gas chandeliers. This particular device was invented by Mr. John B. Verity, whose firm built many of the fixtures for the English company, and constructed the notable electroliers shown at the Crystal Palace Exposition of 1882.

The streets and bridges of the Holborn Viaduct were illuminated by incandescent lamps turned on and off from the station, and a device designed by my assistant, Mr. Cunnington, was used experimentally for turning on a second lamp should one of the two lamps in the post give out.

Dr. Parker's City Temple was supplied from this station, and was the first church in the world to be lighted by incandescent lamps. I well remember the astonishment of Dr. Parker and his associates when they noted the difference of temperature as compared with the gas. I was informed that the people would not go in the gallery in warm weather owing to the great heat caused by the many gas jets, whereas on the introduction of the incandescent lamp there was no complaint.

The operating room of the General Post Office, a long distance away, was supplied with 400 Edison lamps from the station, and I remember the anxiety of the chief electrician, Mr. (now Sir William H. Preece), when the cables were run through the subway under the Holborn Viaduct in which were placed the cables of the telegraph company, and the authorities were certain that the enormous currents carried in the Edison mains would interfere with the telegraph system mains. They had found this the case when the Jablochkoff system had been installed on the viaduct and the cables run through the galleries underneath. Although Mr. Johnson and I called their attention to the fact that whereas the Jablochkoff people used an alternating current, the Edison system employed a low potential direct-current, with both wires enclosed in an iron pipe, still there were many who were sure that there would be trouble, and on arrangements being made for the official test I remember the astonishment on the part of the telegraph people when I informed them that the current had been on for a good part of a week, and there had been no effect noticed on the telegraph system.

Of course, this was many years ago, and the large size of the mains employed in the Edison system and the previous experience

which had been had with the Jablochkoff system naturally caused considerable anxiety.

For throwing the load of lamps from one "Jumbo" machine to another I constructed a huge snap switch, there being 16 metal pawls mounted on a ring of brass, these pawls resting on 16 teeth of the revolving disc. One-half of these teeth were ebonite, and were set into the brass plate which the other teeth formed a part of. Turning the handle of the switch would break the circuit simultaneously at 8 points. There were large rubbing surfaces and powerful springs employed. We also designed the first automatic circuit-breaker ever built, and the drawing of this is still in my possession, although the circuit-breaker itself was never completed.

Early Electrical Days at Cornell.

BY PROF. W. A. ANTHONY.

When I went to Cornell University in 1872, the development of the dynamo electric machine had just begun. Accounts of the Gramme machine had appeared in some of the technical journals. I immediately went to work to design and build one, which served a very valuable purpose in the experiments at Cornell University and I followed with the keenest interest everything that took place in electrical development during those early years.

For convenience in communication with the various departments of the university and the people in the village of Ithaca, a telegraph line was established which finally developed to something over forty offices in 1876, when we began to hear of the telephone. I was immediately interested in that and I think it was early in 1877 I succeeded in obtaining some of those wooden hand telephones, which I connected to this telegraph line, and used them in connection with the telegraph instruments. Very shortly after this the telegraph line was changed to a telephone line, battery call bells and telephones being substituted for the telegraph instruments.

Only a single telephone was used at each office, parties using it alternately as the transmitter and receiver, and many ludicrous incidents occurred from two people attempting to carry on a conversation with each other and both talking at once or both listening at once. This telephone line led to the development of a telephone exchange, which obtained quite a large patronage and employed all-night operators before we had gone so far as to use both transmitter and receiver at the subscribers' offices.

In connection with the early development of electric lighting I remember well returning one night from Washington. The train stopped at Menlo Park, not far from midnight. I saw some incandescent lamps lighted about the grounds. I immediately got off the train to try and see what was going on. Lamps having filaments of the old cardboard carbon were scattered here and there about the grounds and were evidently in use in some of the houses. I found my way to the workshop and to the dynamo room, where one of the earliest of the Edison dynamos was in operation supplying these incandescent lights. On a large table located in the center of the room of one of the work rooms was a Thomson galvanometer with its lamp-stand and scale enclosed by a screen of black cloth so that its indications might be better observed, and this was serving as a voltmeter for indicating the voltage of the machine. Persons about the grounds were calling in by telegraph and making various suggestions about the illumination which the operator at the instrument was endeavoring to carry out, when all at once the lamps began to flicker ominously and finally went out. I went to the dynamo room, to find Mr. Edison himself there in a considerable state of excitement, ordering instruments brought for making a test. It was found when the machine was stopped that one of the coils had burned out. Another armature was in process of winding, but it was hopeless to think of completing that and getting the lights into operation again that night, or rather, morning, for it was getting to be near three o'clock. Mr. Upton, one of Mr. Edison's assistants, very kindly took me with him to his house, which provided for the hours remaining between then and daylight, the disposition of which I had not at all considered when I left the train.

Remembering all this as vividly as I do, the growth of and development of telephone communication and of electric lighting in these later years seems to me a thousand times more marvelous than to those whose memory does not extend back of 1881.

Before leaving Menlo Park I was given a card on which was mounted the punched cardboard horseshoe and inside of it the corresponding carbonized horseshoe showing the shrinkage in carbonizing to be something like a quarter.

The Captains of Industry in the Electrical Field.

BY C. J. H. WOODBURY.

YOUR reminder of my contributions to the editorial columns of the *Electrician* in 1882 recalls several lines of reminiscence, one of them being that it did not take much to make an editor in those days.

It appears to me that the most notable element in electrical matters, has been that of the men who made all other things possible, that is the administrative leaders in these enterprises. The magnificent figures of the census contained in a recent issue of your journal which stated the present measure of electrical development, caught in its increasing growth like a bird on the wing, may well inspire feelings of reminiscence upon the total development of thirty years. Week by week the advance has been chronicled, and year by year its totals summarized, but the whole term gives an aggregate which furnishes a bewildering comparison.

As the development of Grecian art in twelve years produced the Golden Age of Phidias, so the genius of invention applied to electric lighting, distribution of power and transmission of speech in the years immediately following the establishment of your journal in 1874, were so brilliant as to afford but little opportunity to make any discriminations, but it is worthy of note that all of these inventions were applied to public weal rather than to individual benefit, in the exercise of that true socialism which builds up the interests of all, and does no harm to any.

It is in no sense of disparagement to those electric inventors, whose skill produced the essential initiatives of electrical development, that attention is called to the importance of the type of human skill exercised in that administrative ability which established and operated the enterprises engaged in manufacturing and conducting these electrical undertakings.

The early dynamos savored of the laboratories where they were invented, and it devolved upon others to reorganize the machines to conform to the requirements of factory production, and continuous service.

The lack of suitable supplies for the manufacture of electrical plants created a demand which produced numerous lines of subsidiary manufacture.

The gap in insulating materials between those of submarine cables and of door bell wire was soon filled. The requirements of central station plants for the various electrical purposes have taken the best suited elements of other mill architecture, and blended them into special types of buildings whose permanency is a token of stable, continuous service.

The whole business of the manufacture of prime-movers lost its precedence, and became subsidiary to the electrical demand which required radical changes in steam engine and water wheel to fulfil conditions of improved regulation and economy.

The control of the electrical output to meet the variable demand has developed switchboards and their accessories to an extent which constitutes new systems of mechanical arrangement.

The operation of these plants has in turn required new systems of commercial organization to coalesce the many details required by the public corporation with their privileges from the municipality, in order to give service to the individual consumer intent upon his own wants. This has required a high type of business skill in the operation of all electrical enterprises, particularly in the case of telephone companies where the great number of patrons and the corresponding number of lines of connection has rendered the problem one of infinite detail, in the close relation of the many patrons with the company and with each other. It is in the development of the telephone service to the present standard that American skill has shown to great advantage in comparison with what has been done in other countries in the application of electricity to the service of mankind.

In all of this work beginning with the original devices of electrical inventors, and extending to the application in commercial details of the systems in their respective fields, the pre-eminent service has been that rendered by men whose broad scope was endowed with sufficient imagination to foresee the ultimate possibilities of the demand for applied electricity, and with adequate knowledge of present events to provide for the future by selecting competent men to whom were assigned the tasks of solving engineering problems, and above all, these men were equal to the greatest task of all by their power of inspiring confidence in capitalists who invested the enormous amounts essential for establishing these electrical industries, and in this respect the work of these leaders has constituted the greatest element in this electrical development.

Electrical History and the Importance of Systematic Inspection.

By Ralph W. Pope.

THE gradual advance to the present standard of electrical engineering practice is now so generally recognized that there can be little excuse for the crude construction which is still permitted in various parts of the country. Twenty-five years ago telegraph construction was perhaps the only model, and even the limited experience in that branch was not profited by as it might have been. The original telephone lines were built without regard to permanency, while the electric light lines in our principal cities eventually caused losses of life and property directly traceable to inferior construction that finally led to a public demand that all wires should be placed underground. This naturally led to improved construction, as any other procedure was practically impossible. In spite of the objections to underground work on the part of many of the electrical companies, the best electrical engineers insisted that the problem was largely financial, and their opinions have been justified by experience. Possibly New York City is now the leading example of general underground construction for all classes of service, but even here there are doubts as to the possibility of a conduit electric railway on West Street. The financial return from all classes of service in New York are sufficient to warrant an investment which might be prohibitive in many other cities. Whether underground or overhead construction be adopted, however, proper electric service demands the best, and wherever the population is sufficiently dense to offer a proper field for its establishment, every precaution should be taken to prevent accident which may lead to financial loss through damage suits or diminished revenue.

It is not enough, however, that the original construction in New York should be of the highest class, as the question of proper maintenance is equally important. When everything is new, repairs may not be necessary and if proper care is not exercised there is likely to ensue a period of general break-downs that should be avoided. Frequently an electrical system is properly maintained for years, when a change of administration introduces a policy of so-called economy, and a large proportion of the income previously appropriated for maintenance is diverted to the payment of increased dividends, reflecting corresponding credit upon the new management, while the gradual deterioration of the plant will, in a few years, lead up to extraordinary cost of repairs or possibly reconstruction, which might have been readily avoided.

In most cases periodic inspection will avert many accidents, and gradually lead up to systematic renewal of plant which will insure practically continuous service. Too frequently the inspection is a minor portion of the duties of those who are otherwise engaged, or the inspection and repairs are made under the supervision of one person, or the whole system may be operated until the break-down occurs, and then it may, for lack of time, be fixed temporarily, and subsequently neglected, when the same operation is repeated. Such cases are likely to occur where a manager is loaded down with office work, and while he may nominally look out for weak points in the system, he is practically unable to do so, or prefers to confine himself to the desk and take his chance that everything is all right outside.

The advantage of thorough inspection was impressed upon the writer when engaged in the service of the Gold & Stock Telegraph Company in 1873. At that date this system was probably the highest development of electro-mechanical engineering, for the reason that about 1,000 instruments were required to be in perfect condition in order to give satisfaction to the subscribers. Each inspector was allotted 100 instruments on about five different circuits, and was held responsible for their operation. He was expected to visit each instrument twice a week, and see that it was properly cleaned, adjusted, oiled, inked and supplied with paper. So far as actual visitation was concerned, he could, to a certain extent, regulate his own movements. The circuits being grounded at the end, it was important that the last instrument on each should be examined every morning, after which inspection could proceed according to personal preference. Each inspector was allowed a quota of spare machines kept in readiness by running a short time on a test circuit. Complaints from subscribers were made at the superintendent's office, where they were tabulated by the month, and when the bulletin was posted a bonus of five dollars was paid to the inspector having the least number charged against him. There was an element of chance in this, for an occasional circuit trouble might bring in twenty complaints on one day, while there were occasional instances of a clean score for the month. In addition to the regular force, there was an office inspector, to be sent out on call, while each of the regulars in turn took a day inside. The chief inspector must not be overlooked, as he was the man who was supposed to keep all "keyed up" to a proper performance of their duties, and while at that time his subordinates may not have properly appreciated his electrical and mechanical ability, he was certainly gifted with a microscopic eye, and the faults which the inspectors may have entirely overlooked were duly magnified when entered upon his report of general inspection. The very best of overhead line construction was at that time insisted upon, and when on one occasion the entire system was broken down by a heavy sleet storm, every inspector was detailed to assist in its reconstruction and the orders of the superntendent were to rebuild if possible so that the lines would stand if a similar storm should come along next day.

Having been out of practical electrical work for twenty-five years, the writer is not in a position to state whether similar practice prevails elsewhere, but observation has led to the belief that proper inspection is not universal, and that many serious accidents might be avoided and better and more continuous service provided if serious attention was given to this important branch of service. During the discussion of high-tension distribution at the Institute meeting in December it was stated by one speaker that in a Massachusetts town a high-voltage wire passed through a group of telephone wires only ten inches distant from them. In a New Jersey town the writer every morning last summer passed a frame building where a leading-in "weather-proof" wire was drawn taut over the edge at the end of an iron pipe which ran down into the ground. The attention of a policeman was called to the danger, and he said he would report it and have the wire changed, but nothing was done. No doubt there are many other danger points in the same town which would readily be seen by a competent inspector. While small companies cannot afford to employ expert inspectors continuously, it appears quite feasible for them to combine and obtain their services at regular intervals. Such traveling inspectors would probably be more efficient than local employees, by reason of their wider experience and freedom from the suspicion of meditating injury to the standing of the regular employees, whose work they might be expected to criticise. Such a plan of inspection could be readily systematized by a regular report of faults to be rectified, followed by a subsequent examination, when it could be ascertained whether the work had actually been done as specified.

The Growth of the Sale of Current.

By W. F. White.

The commercial electric lighting and electric railway industries of the world have been created since 1874. Thousands of millions of dollars are now invested in them in the United States alone. The stride is without a parallel. The growth has not been of the mushroom order, but has been a growth with stability. No class of securities withstood the 1893-97 period of financial depression so well as the securities of meritorious electric properties. This record will be maintained. Good electric securities will increasingly win the favor of investors.

The field for the sale of electrical energy is comparatively unexploited. Its sale for general power purposes has only begun. In not a single large city of the United States have the possibilities of the industrial power business been fully developed, much less exhausted. In many of our best cities to-day the gross receipts from the sale of electrical energy for all purposes do not exceed $1.00 or $1.50 or $2.00 per capita per annum. Such volumes of business can be multiplied three, four or five fold.

The existent demand unsatisfied, the great undeveloped market at hand waiting only to be cultivated, insure the future, and guarantee against the effects of even a period of general commercial retrenchment. Come good times, come bad, the electric industries will constantly grow, electric investments will be increasingly profitable and popular, and therefore both commercial and engineering development will continue on the forward march.

The Foundation of the Modern Street Railway.

BY BRIG. GEN. EUGENE GRIFFIN, U.S.V.

YOU ask for my personal recollection of the electrical evolution of the past thirty years. My personal experience goes back only to 1887, when, as assistant to the engineer commissioner of the District of Columbia, I made a tour through the principal cities of the United States in search of information concerning telephone, telegraph, arc light, incandescent light and electric railway underground wires. I secured a great deal of valuable data on this interesting subject (valuable, in the light of the progress made in burying wires up to that date) and incidentally I became interested in and inspected several electric railways and secured data concerning the same. Upon my return to Washington I made a report to the engineer commissioner (Col. Wm. Ludlow) on the subject of electric railways (December, 1887,) preparatory to the more extended report upon underground wires. My report on electric railways was called for by the United States Senate and published as a public document. I joined the Thomson-Houston Electric Company, of Boston, in March, 1888, and as a result my report on underground wires was never made.

The report on electric railways referred to above shows that in the summer of 1887 there were twenty electric railways in the United States and Canada, viz.: Appleton, Wis., Appleton Electric Street Railway, 4½ miles, 5 motor cars, Van Depoele system; Asbury Park, N. J., Sea Shore Electric Railway, 4 miles, Daft system; Baltimore, Md., Union Passenger Railway Company, Daft system; Binghamton, N. Y., Washington Street & State Asylum Electric Railway, 5½ miles, 6 motor cars, Van Depoele system; Brooklyn, N. Y., 6 miles; Denver, Colo., Denver Tramway Company, 4 miles, 7 motor cars, Short-Nesmith system; Detroit, Mich., Detroit Electric Railway Company, 2 miles, 4 motor cars, Van Depoele system; Detroit, Mich., Highland Park Railway Company, 3 miles, 2 motor cars, Daft system; Gratiot, Mich., Gratiot Electric Railway Company, 1 motor car, Van Depoele system; Kansas City, Mo., Kansas City Electric Railway Company, Henry system; Lima, Ohio, Lima Street railway Motor & Power Company, 6½ miles, 7 motor cars, Van Depoele system; Los Angeles, Cal., Los Angeles Electric Railway Company, 5 miles, 4 motor cars, Daft system; Mansfield, Ohio, Mansfield Electric Railway, 4½ miles, 5 motor cars, Daft system; Montgomery, Ala., Capital City Electric Street Railway Company, 12 miles, 14 motor cars, Van Depoele system; Port Huron, Mich., Port Huron Electric Railway Company, 2¾ miles, 3 motor cars, Van Depoele system; St. Catherines, Ont., St. Catherines, Merriton & Thorold Street Railway Company, 6 miles, 12 cars, Van Depoele system; Scranton, Pa., Scranton Suburban Railway Company, 4 miles, 7 motor cars, Van Depoele system; Wichita, Kan., Wichita, Riverside & Suburban Railroad Company, 4 miles, 6 motor cars; Windsor, Canada, Windsor & Walkerville Electric Railway Company, 1½ miles, 1 motor car, Van Depoele system; Woonsocket, R. I., Woonsocket Street Railway Company, Bentley-Knight system.

There were 22 roads being constructed or under contract, including the Sprague road in Richmond, Va.

This was the very beginning of the modern electric railway development. I became general manager of the railway department of the Thomson-Houston Company, and on the 4th of July, 1888, we started our first car at Crescent Beach, Mass. This car was equipped with two F. 20 (10-hp) motors, which were the first Thomson-Houston motors built for railway equipments. (The Thomson-Houston Company had previously built several motors of different design for the Bentley-Knight Company.) In the fall of 1888 the Eckington & Soldiers' Home road was constructed in Washington. This road was a long step forward in the progress of the electric railway. The overhead line was installed with center poles, a very neat and attractive looking construction.

Then we made our great contract with the West End Street Railway wherein we agreed to keep the apparatus on the cars and the overhead lines in good working order at three cents per car mile. This guarantee ran for five years and was a very serious undertaking for an electrical manufacturing company to assume at that time. Within two years, however, the West End Company found it to their advantage to relieve us from this guarantee and to take over the maintenance themselves.

Sprague's Richmond road, the Eckington & Soldiers' Home road, and the West End road may be regarded as three of the stepping stones on which the electric railway business crossed the stream of possible failure and landed safely on the side of success. Within two years, i. e., in 1890, the railway business of the Thomson-Houston Company had grown from nothing to nearly $4,000,000 per year. We were unable to meet our customers' demands.

During the period of sixteen years in which I have had general charge of the electric railway business of the Thomson-Houston and General Electric Companies, the industry has developed from a total of about 100 cars electrically equipped (in the United States) in 1887, to a total of about 55,000 cars electrically equipped in 1904; from a 10-hp motor per car in 1887 to two (and even four) 200-hp motors per car in 1904; from the small "bob-tailed" car of 1887 to the 48-ton, 60-ft. interurban car and 2,250-hp electric locomotive of 1904. It has been an interesting development. I regard myself as fortunate to have been connected with a development which has added so much to the wealth, happiness and comfort of mankind.

If I were asked to summarize the improvements made in electric apparatus for street cars since 1887, I should do so as follows: Large motors, single reduction motors, enclosed motors (waterproof), increased number of poles (reducing weight), form-wound armature coils, ironclad armatures, carbon brushes, casings to permit gear and pinion to run in oil, series-parallel controller, circuit-breakers, underground working conductors.

Practically all of the elevated and underground railways in the world have been, or are being, equipped electrically. Suburban roads have been constructed and are operating electrically where no roads would have been built but for the advent of electric traction. One of the large trunk railways has already contracted for an electrical equipment to operate not only its suburban service in the vicinity of New York, but also its express service within a radius of forty miles of New York City; other trunk lines are preparing for the execution of similar contracts, and it is only a question of a very few years when the steam locomotive will have disappeared from the vicinity of New York City. Similar results may be expected in other large cities. It is then but a step to extend the electric service to cover all transportation between the large cities of the East, and it is by no means improbable that many of us will live to see the day when the steam locomotive is as much of a rarity as is the horse car to-day.

An Era of Central Station Underground Work.

BY JOHN LANGTON.

A feature in the history of electric lighting, which now runs some risk of being forgotten, is the important part played in the development of central stations in large towns, by the Edison system of underground conductors, known as "electric tubes." The Pearl Street Station in New York, with its low voltage, large current and a considerable area of distribution, necessitated unprecedentedly large conductors which no existing system could adequately supply. Overhead wires would have been intolerably cumbersome, even had they not been barred by the permanent character of construction which was aimed at, and which could only be achieved by underground distribution. The service to be given was strictly analogous to the supply of gas and water, and Mr. Edison's idea of iron pipes containing insulated copper rods, to be manufactured in fixed lengths and joined together in the trench, was characteristic of his direct mode of thought. Their construction and the development of details were confided to the remarkable mechanical skill and judgment of the late Mr. John Kruesi, whose resourcefulness and indomitable perseverance overcame the faults and troubles inseparable from a first essay in a new field, and under whose direction a flexible, reliable and well-standardized system of underground conductors was produced which covered a wide range of sizes. The larger Edison stations constructed in the middle 80's were made possible by electric tubes. No cables then available could stand the severe conditions which the tubes successfully met. Hence, electric tubes did yeoman's service in the early demonstration of the commercial possibilities of central station work; possibilities which justified the construction of conduits and stimulated the production of cables. It is safe to say that the present wonderful development of central station work would have been several years delayed but for the share taken by electric tubes in the pioneer work of electrical distribution from large central stations.

The Development of Telephone Engineering.

BY ANGUS S. HIBBARD.

I should consider the thirtieth anniversary of your journal an appropriate time to remark upon the widespread and ever-growing appreciation of the telephone which has scarcely passed its quarter century mark. Born a marvel in electrical art, treated at first as almost an experimental freak, the telephone in its early years traversed a hard road. Unknown and unnamed obstacles obstructed it. New electrical terms and laws were pushed into existence by means of it. Difficulties of all kinds and descriptions were encountered and surmounted by an enthusiastic and devoted band of men of America, who first earned for themselves and gave to the world the title of telephone engineer. With no past experiences to guide them, these men made technical and electrical history as they advanced. Their years of labor have cleared away electrical and mechanical difficulties as they have arisen. The telephone has, by reason of their work, been proved to be the great time saver, and it would be difficult to exaggerate the millions of hours saved daily by the millions of people who now avail of its service. Ever ready at hand, on the desk, in the room, by the fireside or bedside, the telephone, by reason of skillfully designed systems and well-trained service brings, in America, the greater part of a continent within speaking distance. Ten years ago a city having 10,000 telephones in service led the world. To-day there are several single offices in New York or Chicago accommodating the service of more than 10,000 instruments. The tremendous value to the public of such an extended and unified service can scarcely be overestimated. New York with 120,000, Chicago with nearly 80,000, Philadelphia, Boston, Brooklyn, Cleveland, Cincinnati, St. Louis, Omaha, Kansas City, Minneapolis, and all other leading cities of the country, following closely in good proportion to their population, these and more than 20,000 other cities, towns and villages directly connected by long-distance lines, all within earshot, represent an intercommuncating service and system never before equaled nor even dreamed of; while the Pacific Coast with a system of more than 40,000 telephones, centering in San Francisco, is equally developed throughout an area nearly 2,000 miles in extent.

It is not inappropriate that these hundreds of men who have devoted themselves untiringly to the work should at this time review the great and accomplished factor they have been building, nor that others in contemplating it should realize that it represents to-day the accomplishment of that devoted and able technical force now widely recognized throughout the country as telephone engineers.

The First Edison Isolated Lighting Plant on Land.

BY FRED'K A. SCHEFFLER.

You ask me to give you some personal reminiscences of interesting periods or occurrences in regard to my connection with the electrical business. I cannot recall anything perhaps which will be of more interest than to state briefly an outline of what I believe was the first private house isolated plant installed by the Edison Company twenty-two years ago.

This plant was put in Mr. W. H. Vanderbilt's residence, corner of Fifth Avenue and Thirty-first Street, during the summer and fall of the year 1881. It was located in the basement of the beautiful new mansion, which he completed about that time.

The appurtenances consisted of two 60-light old "Z" type Edison dynamos, having a combined capacity of 120 16-cp, 110 volts, with a countershaft on the floor connected by belts to two 6½ x 8 high-speed Armington-Sims engines. The steam was supplied to these engines from a locomotive type of boiler designed especially by the writer to fit the circumstances and the space available. It was built by the Baldwin Locomotive Works, and covered with wood and Russia iron lagging with brass bands.

The house was wired for over 1,000 incandescent lamps, 16-cp each, and as it was the intention even as far back as that date to supply eventually that part of the city with current from a central station, the mains were carried in the vicinity of the street for future connections; and as the wiring was done on the old two-wire system, these mains consisted of a bunch of small wires of such a number that the combined size of each main was about three inches in diameter.

As it was impossible to operate more than 120 or 130 lamps at any one time from the isolated plant, the various rooms could not be lighted at the same time, and this would have proved to be a decided annoyance to the owner, if the plant had remained in the building for any length of time. For the purpose of illustrating what could be done with electric lighting for private houses, the results obtained were eminently satisfactory. The arrangement was objectionable from the standpoint of the owners, particularly the ladies, who did not like the idea of living in a house where there was so much noise from the machinery, and especially with a boiler carrying 120 pounds of steam pressure. The whole machinery was removed by the Edison Company before the owner ever occupied the residence.

One very interesting result of the test and exhibition of this lighting plant occurred one evening when the owner and friends had been invited to make an inspection. Just before the visitors arrived, tests of each room were made by turning the lights on and off from the switches located at convenient points on the walls of each room. Everything was found perfectly satisfactory, with the exception of one room on the second story front facing Fifth Avenue. This room was beautifully decorated with "cloth of gold" on the walls. The lighting was effected by single pendants upon the ceiling and two or three side lights or brackets. The latter were combination fixtures, arranged with wires to light the gas also by electricity. In this room when the switch was turned on the most beautiful effect was noticed of the current traveling all around the room on the wall and in one place this "cloth" was cut from a side bracket down to the wainscoting as clean as though it had been cut with a knife. It was, of course, discovered that there was a short-circuit between this particular bracket and some other part of the room; but whether the fault was due to defects in the Edison circuit, or to the plumbers who installed the gas fixtures, or to the parties who put in the gas lighting wires, could not be discovered. The Edison Company paid for a considerable amount of repairs which were necessary to the decorations in the room.

The Field as Seen by One Who Worked With Farmer.

BY GEORGE A. HAMILTON.

I want to congratulate the ELECTRICAL WORLD AND ENGINEER on the completion of its third decade in electrical journalism; on its magnificent success—the compensating return for the sacrifice made by its founder—and on its active and faithful chronicling of the marvelous electrical progress that has been made during this period.

When I recall that thirty years covers almost the beginning, development and maturity of the electrical industries of to-day, I find it difficult to realize the fact. Yet such it is. All are, with slight exception, embraced within the lifetime of this publication.

The dynamo had made its appearance only a little while before. Previously, too, the telegraph and electroplating occupied almost alone the entire electrical field.

At that early day it was my good fortune to be associated with Prof. Moses G. Farmer at Boston. He had simultaneously, with Wilde, applied the self-exciting principle to the dynamo and was then actively engaged in the manufacture of various types of machines for electroplating, lighting, torpedo and telegraph work.

At this time, too, Prof. Bell began his preliminary experiment, which later gave us the speaking telephone. I was an enthusiastic participant in some of these, and recall with interest now the fatherly caution then received, not to allow myself to be unduly carried away by some of his theories.

The giant strides that have been made in so many directions since are familiar to all. They have been duly noted in the ELECTRICAL WORLD AND ENGINEER and in its contemporaries. Few then realized the force and the magnitude to which these varied interests would attain or realized the vast amount of capital they would employ. Tesla's communication with Mars, in fact, appears hardly less possible now than wireless telegraphy, for instance, did then. Loomis meanwhile has been forgotten.

It is but a step to speculate on the future. Will the next thirty years show progress as remarkable as the past? Who can say? At the beginning of the period just elapsed there were comparatively few workers in the field. The number to-day is multiplied many times over. They are young, energetic now, far better equipped, theoretically at least, than their predecessors. They have, moreover,

the incentive of the latter's accomplishments and emoluments before them. It would be strange, indeed, if they failed to score high.

Success to them! Success and long life also to the ELECTRICAL WORLD AND ENGINEER, that it may continue to record and promulgate their achievements as well!

An Era of Electrical Expansion.

BY HENRY A. REED.

I wish first to congratulate you that you were not born earlier. As great men depend for development upon great opportunities, which great events furnish, and the favorable issue of great events depends upon the genius and fidelity of the great men whom they arouse to action, so a great journal to succeed must be called into being by necessity and must minister to that necessity. Prior to your advent, electricity was used commercially only in telegraphy and the principles therein involved, or at that time being discussed, were not sufficiently great, intricate or numerous to inspire, or the dependent industries sufficient to support, a first-class electrical journal. The developments which rapidly followed furnished plenty of material for your consideration, and from the general appearance the commercial results have kept most of your attachés far removed from the want of worldly comfort.

The different system of multiplex telegraphy were being more discussed, the arc light was demanding recognition by capitalists, and in 1876 the success of the telephone was established by its exhibition at the World's Fair in Philadelphia. In 1879 Edison had the incandescent light in commercial shape. A little prior to this date he had perfected the electric pen and had introduced the phonograph. All of these and other inventions relative to light, heat and power required factories for the manufacture of the instruments and attachments necessary for their operation and supply stores for their distribution among the numerous and eager customers.

The effects of the magical powers of electricity were nowhere more noticeable at this time than upon the people. It seemed as though everyone not fossilized was electrified and ready to swallow almost any kind of a pill with an electric coating.

Prior to your advent very few of our schools or colleges had special courses in physics. Civil engineering had been taught at West Point and at the Troy Polytechnic for several years, and Stevens Institute of Technology for mechanical engineering had been opened in 1871; but the rapid developments in the science of electricity demanded not only organs but more schools, and our colleges and universities in great numbers vied with each other in their haste and in the completeness of equipments to meet the demand. Well do I remember when the degree of Civil Engineer was scarcely known in this country.

Our old surveyors could run boundary lines or levels for canals and railroads, but knew little about building bridges or dams. High Bridge and the first Croton dam were built about 1840, and considered the greatest engineering works of this country. High Bridge answered its purpose, but the dam was carried away by the next spring freshet, because the foundation was not properly secured.

Since railroads must have bridges, and rivers must be dammed, the young men who were competent to superintend the operations could wear high collars and flowing sleeves (then the rage) which few of their companions could afford. The result was that the Troy Polytechnic was crowded with young men dreaming of high collars. This may have had something to do with starting the great collar industries in that city. Unfortunately, for some of the young men, railroads did not multiply as fast as civil engineers, and before your début the market was overstocked with the latter.

The rapid development of electrical inventions and electrical industries have had a similar effect upon the young men coming upon the stage during your existence, and an over-abundance of electrical engineers might seem to be feared. But by expansion and imperialism our country is much larger and richer than at the time of the civil engineer boom, and there appears to be plenty of room at the top of the present ladders, with higher peaks already in sight awaiting for ladders and for men.

That the ELECTRICAL WORLD AND ENGINEER may keep in the future as it has kept in the past, abreast of the front line in every advance, is the earnest prayer of one who was in the harness a quarter of a century before your advent.

The Evolution of Dynamo Design.

BY DAVID B. RUSHMORE.

THE science of dynamo design dates from the discovery, by Faraday and Henry, independently, of the law of electromagnetic induction, which states that the electrical pressure generated in a coil of wire, by relative motion between it and a magnetic field, is directly proportional to the rate of change of interlinkages of turns and lines of force. The evolution of this science has been a steady growth in which a process of continual differentiation has taken place. An increasing knowledge of electrotechnics and of the qualities of material employed, has given an ever-growing precision. Applications to numerous fields for the transmission of power and intelligence have given to dynamo machinery and allied apparatus a field of utilization never before equalled, and the stimulus of a world-wide competition has transformed the subject from one of technical interest to that of a commercial consideration of the greatest financial importance.

The original apparatus contained the embryo of the present alternating-current transformer, but the infant dynamo appeared so soon afterwards that both may be said to date from the year 1831.

LIMITS TO DESIGN.

As electrical machinery is designed with regard to the limits imposed by the conditions of operation, it is at the factors affecting such limitations that we should look to understand the lines of development on which progress has been made. An increase in temperature under load, due to energy losses in copper and iron, is found in all electromagnetic apparatus, and the point at which the insulation is injured determines the maximum allowable heating. Besides this common attribute that of regulation of voltage in generators and of speed in motors is next in importance. All commutator machines, both direct and alternating current, have, as a property of first importance, the subject of satisfactory commutation. Standards have undergone great change. What was satisfactory fifteen years ago in regard to the heating, regulation and commutation of dynamo machines would not be accepted to-day. Also in different countries, and with different manufacturers and users in the same country, the requirements in these respects varied widely. Fortunately, engineering societies are fixing the standards for classes of apparatus and conditions of service, thus bringing about uniformity in regard to designing limits.

DIRECT-CURRENT GENERATORS.

The limiting conditions in design of direct-current generators are, in order of their importance, commutation, heating, regulation and efficiency.

Commutation.—Faraday's first machine, shown in Fig. 1, was a unipolar. The simple collecting rings of the early machines were easily changed to two-part commutators. The many interesting experimental machines which formed steps in the early development had little of real design about them. The mechanical construction of the commutator, now one of the greatest arts in dynamo building, was the source of much trouble as machines increased in size. Different materials, iron, brass, gun metal and various alloys of copper were used for bars, and a still larger variety of insulating substances between segments before copper bars and micanite insulation became standard. Sparking was regarded as a necessary evil and as long as the machine operated at all it was considered more or less satisfactory. The early magneto machines, as well as those of Siemens, Pacinotti, Gramme, Brush and Thomson, possessed great armature inductance, but where the outputs were small this caused no serious sparking; and, when it was necessary in the larger generators, special means, such as air blasts at the brushes, were used to prevent harm. When the manufacture of dynamos reached a commercial stage, about the only point in design which was considered, was to keep the pole arc down to a certain percentage of the pitch. These machines, such as the Edison bipolar type, were surface-wound, smooth-core armatures with large magnetic air-gaps and the brushes were shifted with load when necessary.

Designers then began to study armature reaction and a large number of different pole constructions were tried. A rule used in designing was to keep the induction in the air-gap under the weakened pole corner above 1,500 for drum armatures and above 2,500 for ring armatures. The maximum voltage between bars was fixed, but as this is in reality no criterion of commutating ability, it naturally varied greatly, being taken later at about 25 volts for an average value. A careful study was made of armature reaction, and mag-

netic air-gaps were then proportioned to give desired relations between armature reaction and field excitation at full load. Also the amperes per inch of armature circumference were used to judge commutating ability. Railway work, with its suddenly varying loads and calling for fixed position of commutation introduced the carbon brush. High resistance commutator leads were tried and a great number of special armature windings, such as the Sayers, and commutating lugs and pole face windings, as in the Thompson-Ryan machine. A careful theoretical study of the very complicated phenomena of commutation was made by several men, among whom must be mentioned Prof. E. Arnold, and the various factors which affect this action were expressed mathematically. The inductance of the armature coil while passing through the period of commutation, was discovered to be of vital importance and many experimental results and rules deduced therefrom have been published. The computation of what is termed the "reactance voltage" of the armature coil is now one of the important determinations in the present design of direct-current machinery. By making a few allowable assumptions

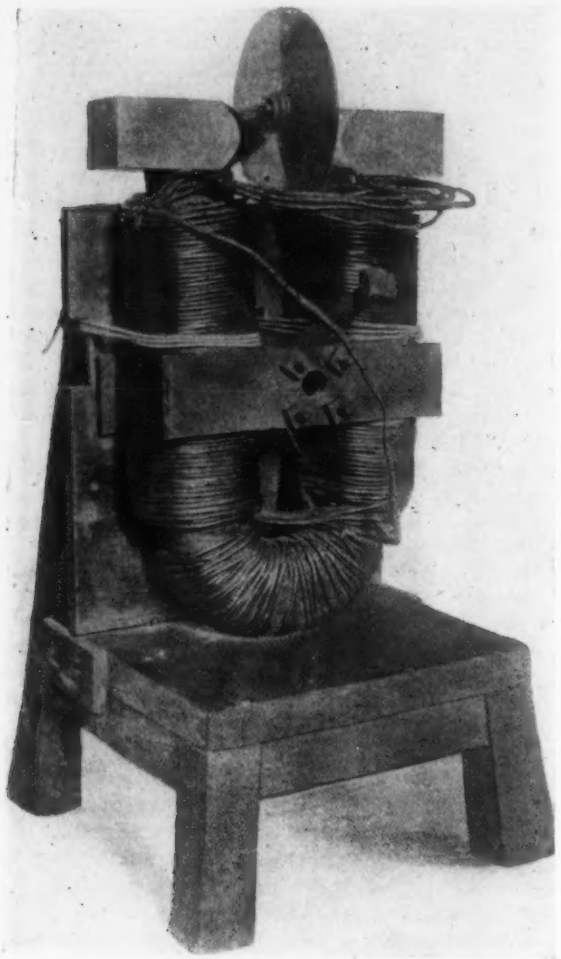


FIG. 1.—FARADAY'S FIRST MACHINE.

and where we have but one turn per coil, the reactance voltage is conveniently expressed by the formula:

$$E_L = 2.5 \times 10^{-8} \times N_B \times S \times Ic \times le''$$

E_L = reactance voltage, N_B = no of bars in commutator, Ic = amperes per conductor, le'' = length over armature iron in inches, and S the revolutions per minute. A large number of generators and converters have been designed using this rule, and it has been found very satisfactory. It must be remembered, however, that it considers but one of the factors, and the limiting value will vary with such quantities as percentage of pole arc, distortion of field from armature reaction, kind of armature winding, number of conductors per slot, number of segments covered by brush, form of slot, ratio of length of idle to active conductor, kind of brush and resistance of armature coil, commutator leads, brush contact, etc.

The subject of commutation is now one of great theoretical and practical interest, especially since the appearance of the alternating-current series, repulsion and compensated motors with commutators. A very careful study is at present being made and the theory has advanced far beyond the point here indicated. It is now possible to pre-determine the curve of current change in the coil with fair precision, and when this can be done the subject has passed from empirical rules to the domain of exact science.

Heating.—All electrical machines are subject to heating and in many cases the output is limited thereby. It is the result of inevitable copper and iron losses—either of which may be nearly constant or vary as some function of the load—and the temperature reached must not exceed the point where insulation receives permanent injury. Generators, motors and transformers are now designed in this respect with attention to the particular conditions of operations.

Early machines were designed for heating by fixing the current densities, and temperatures reached were abnormal. The field coils were in some cases covered with heavy rope and protection from mechanical injury took precedence over heat radiation. The large number of magnet designs used required field coils of various forms and constants for temperature rise varied accordingly. Rules for the determination of magnet windings for given heating and magnetizing power have been and are still numerous, although applicable, with precision, only to machines similar to those from which the data were obtained.

Multipolar construction did much to improve field coil ventilation. The poles have been lengthened to allow exposed ends on both shunt and series coils, bobbins have been removed, and ventilation secured inside the coil by using round coils with rectangular or elliptical poles, heavy shunt coils have been ventilated by dividing them into two parts, making four exposed ends, or by leaving a cylindrical space one-half inch wide lengthwise through the middle of the coil. The varnished round wire has, wherever possible, given place to square and in some cases where the round is used the interstices have been filled with a compound to aid in conducting heat from the center of the coil. By painting the coils black radiation is at its best, and by placing ventilating ducts through the armature, and especially at the ends, also by considerably raising or sinking the fibre wedge in the armature slot to make the cylindrical surface rough, and by running the core at a high peripheral velocity, a maximum quantity of air is circulated most efficiently around the field coil and the dissipation of heat by this means is obtained with the highest degree of effectiveness.

Excepting the pre-commercial forms and arc light machines, the early type of armature was a long, smooth core, covered with wires and the cross connections lapped irregularly at the ends. The heating of different coils varied greatly and the iron core was entirely covered by the winding. Multipolar types allowed internal core ventilation, brought about symmetrical and well-exposed end connections, and increased the armature diameter while diminishing the length. Toothed armatures exposed the core surface, brought some ventilation through the exposed ends, which was increased when the supporting flanges were omitted, and brought the winding and core more closely in contact, thus equalizing the temperatures between the two parts. Increase in capacity necessitated ventilating ducts in the core and these have been increased in number, and in efficiency, by dispensing with the cast plate supporting the separating fingers and attaching the latter directly to the extra heavy adjacent laminations. By proper mechanical construction the direction of the currents of air set in motion by the armature has been guided so as to give a maximum cooling effect for the energy lost in windage. Great reduction in heating and increase in output have thus been obtained by extensions of the armature end plates and by webs placed on the arms inside the core and on the outside of the end plates under the open cylindrical surface of the cross connections.

BRUSHES AND BRUSH HOLDERS.

Excellence in electrical design is of no avail unless accompanied by goodness in mechanical construction of commutator and brush holders. The necessity for using insulation in its construction, the considerable mechanical stress to which it is subjected and the great variations in temperature which it must undergo, all tend to make the large commutator the part of dynamo construction requiring the greatest care. The electrical design of commutators has had to do with voltage between bars, with numbers of bars between brushes and pitch on commutator, with current density at brush contact, with best brush pressure for the peripheral velocity of commutator, with the heating from friction, contact resistance loss and stray eddies, with the insulation of the segments from the spider, the thickness of the segments and insulation between them. Refined electrical commutator design is of recent origin. A great many machines have been designed by assuming the volts between bars, width of brush

and contact density. It is true with low-speed commutators, which existed before the days of converters, this may have been satisfactory. It is, however, at present necessary to make a detailed calculation regarding the heating of the commutator as well as the conditions of commutation.

The use of brush resistance as a factor for successful commutation has changed the metal brush to one of carbon. Here for the last decade a refinement has been in process to suit the resistance, size and lubricating qualities of the material to the special conditions under which the brush is to be used. Carbons and graphites, with various mixtures of lubricating compounds and cementing materials, with and without copper gauze as the carbon, and having undergone various heat treatments, are now the material used for nearly all brushes.

The early brush holders were simple, giving pressure to brush and affording contact for taking off the current. The history of this device shows a wonderful fertility of invention from which a few simple forms have survived. The subject is one requiring illustration for treatment.

DIRECT-CURRENT ARMATURE WINDINGS.

The subject of armature windings may be said to date from the inventions of Pacinotti and Gramme. The ring-wound armature was followed by drum and disc types. A large number of ingenious and interesting windings have been devised. With large outputs but few of these have been successful and in this country but two or three varieties are seen. The possibilities of connections with different armature windings has been thoroughly worked out, principally by E. Arnold, and equations for many possible arrangements have been given. When the conditions for commutation are considered only the simplest types of windings are practicable. Parallel and series or lap and wave windings are the only ones which give satisfactory results. European makers still employ combinations of these, but in this country such exceptions are seldom found. Chord and pitch arrangements of coils are used, dependent upon manufacturers, type of machine and subdivision of winding. When outputs began to exceed a few hundred kilowatts, the series winding became impossible and parallel windings have needed equalizing rings. The use of these is general and is very satisfactory. Modern designing is characterized by subdivision of reaction and heat generation, so we have small conductors, with but few in a slot, many poles, smallest possible number of turns per coil, maximum numbers of bars between brushes, large diameters, short lengths, small sections, etc.

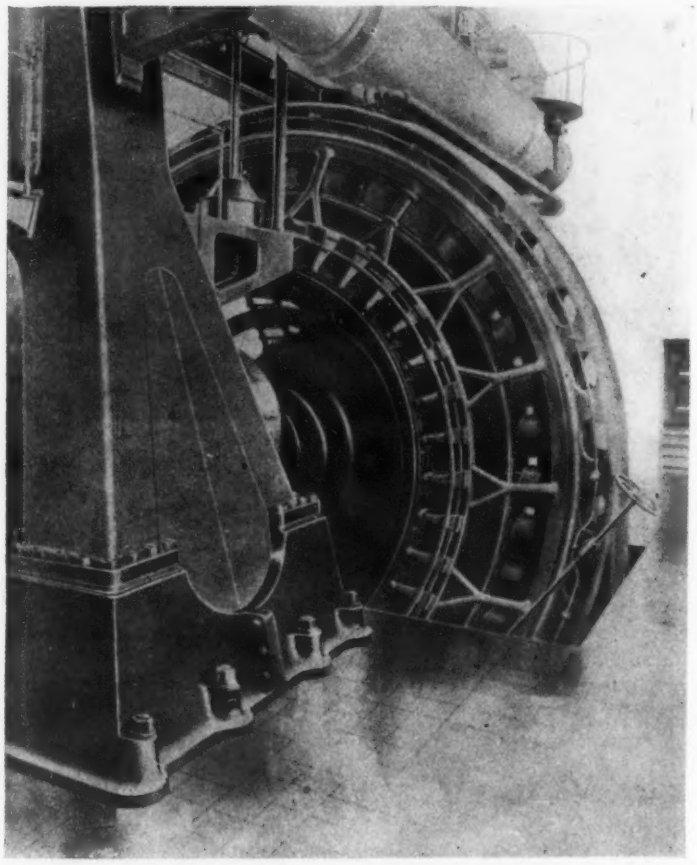


FIG. 2.—3,700-KW GENERATOR.

DIRECT-CURRENT GENERATORS.

The form of field magnet has undergone great change. The two-pole wrought-iron structure has been changed to almost every possible shape by different makers. The greater economy in use of material in multipolar types for large sizes has resulted in the standard form of to-day. Curiously enough, some English manufacturers still cling to the old bipolar construction for large units.

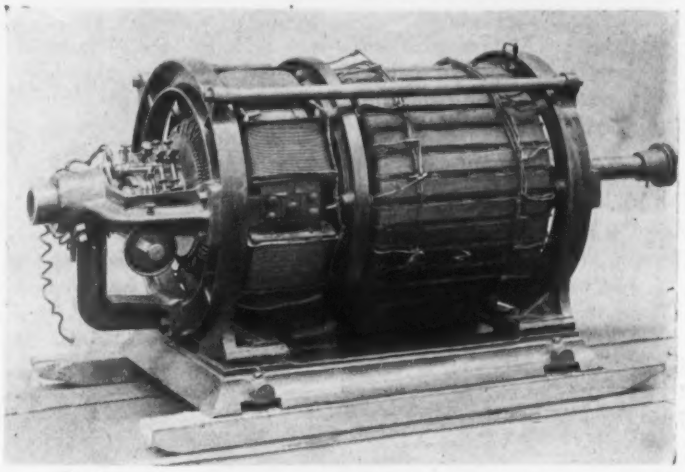


FIG. 3.—REVOLVING-FIELD GENERATOR WITH DIRECT-CONNECTED EXCITER, BUILT IN FRANCE ABOUT 1880.

Wrought iron was at first almost exclusively used for magnets. This was followed by combination circuits of which cast iron formed a part. The art of casting steel is of recent development and has had a wide application. The best steel castings are now magnetically equal to wrought iron. The critical saturation point of steel, its greater conductivity for eddy currents set up by a varying flux, the disparity between necessary sections for magnetic and mechanical reasons with large diameters, some uncertainty with regard to its manufacture and a lack of magnetic retentiveness and stability have caused some manufacturers to substitute cast iron for its use for field yokes, while for pole cores it is still employed. Rectangular laminated poles cast into iron yokes are also used.

External revolving armatures have almost disappeared. Complications in design of special pole shapes, compensating windings, peculiar magnet forms and unusual armature and field windings continually appear, but as yet none have been able to supersede the simple form which is standard to-day.

ALTERNATORS.

Formerly engineers were divided into two classes in regard to the form of current supply which they advocated, and many were the controversies as to the relative merits of direct and alternating currents. The wide application of the latter awaited a successful motor.

In this country the first commercial alternators had smooth-core armatures with flat pancake coils, external yoke and radial internal poles. The periodicities used were 125 and 133 cycles. These machines ranged in output from approximately 50 to 200 kw. The yoke and poles were of one piece of cast iron and owing to the single-phase reaction became very hot. Owing to limitations of pole forms for these high frequencies, and also to the fact that the armature cores were surface-wound and mechanical conditions necessitated certain clearances, these early machines were possessed of excellent regulating properties.

The pulsating single-phase armature reaction made it desirable to use laminated poles, which were cast into the iron yoke. Wear of bearings which allowed the winding to strike the poles, or the accidental falling of some small body on the armature core, would so completely strip off the surface winding that the next change was to use an armature having as many large teeth as the field had poles and to place the wire in large coils on these teeth, pressing them under the extended edges and holding them in place by wedges driven between two adjacent coils. The first so-called polyphase machines in this country consisted of two such single-phase machines with armatures displaced with respect to each other. While a great advance mechanically, the concentrated armature winding and the great pulsation in reluctance of magnetic circuit gave bad regulation and a very irregular wave form. An alternating-current

generator of this type for series arc lighting was developed, by giving it an abnormal armature reaction. The "plus two type" of polyphase generator, in which the armature had two teeth more than the field had poles, was developed and with these was tried a compounding of the machine by use of a series transformer, a two-part commutator and an additional field winding. The increasing demand for polyphase machines and the necessity for good wave form and regulation brought about a distributed armature winding, the frequency in the meantime dropping to 60 cycles.

At about this time a great jump was made and the Niagara type of generator with its internal stationary armature and the umbrella like external revolving field with inwardly projecting poles brought with it the use of 25 cycles.

The last step in the development of this type of alternator has been to make the armature external and stationary and to revolve the internal field. This construction allows the armature to be wound for high voltages and to possess an unbroken electric circuit. The wire field winding has been changed to a copper strip bent edgewise, and with the improvements in mechanical and electrical design we have the present excellent revolving field generator.

In Europe the course of evolution has been somewhat different,

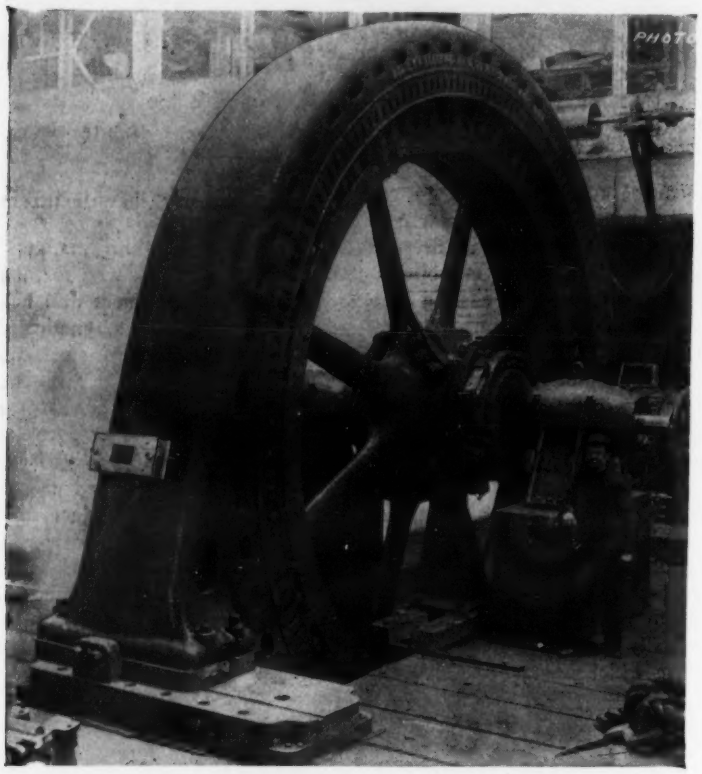


FIG. 4.—MODERN ENGINE TYPE OF REVOLVING-FIELD ALTERNATOR, 2,000 KW.

embracing as it did such types as those of Mordey, Ferranti and Kapp. The result has, however, been the same.

Many different devices for compounding of alternators have been devised, but these have in most cases been extraneous to the generator.

The inductor alternator was early in the field and was for a time decidedly superior to machines which existed contemporaneously with it. The absence of moving wire and sliding contacts, the external stationary armature, the single field coil with its small waste of energy, the almost perfect wave form, excellent regulation, high efficiency, good ventilation and capacity for standing abuse of all kinds, gave it decided advantages. To those who follow closely the development of any path of progress, the influence of fashions as opposed to reason cannot but be apparent. So the fad for revolving-field generators which existed in this country and abroad is now giving place to a reasonableness which leaves the inductor alternators admittedly superior in some fields, equally as good in many and inferior only in few. This refers to the nature of the machine. Comparisons of specific designs can be fairly made only when all factors are considered.

Early generators were of the belted type and 200 kw was considered a large unit. Then came a demand for engine-driven sets, which was reasonable within certain limits; but which for combinations of small output and high frequency was an expensive taste to gratify. Water wheel sets have been made for speeds determined in general by hydraulic conditions and these have and always will be, to a considerable degree, special machines; 300 kw is near the limit for belted machines. Engine-driven alternators have been made up to 5,000 kw and over 40 ft. in external diameter, which is probably the limit as regards size. The new turbo-alternators which promise soon altogether to displace the engine units, naturally run at much higher speeds and are smaller in dimensions; 10,000 kw has been the largest water wheel alternator built.

From the early periodicities of 125 and 133 cycles, the change came to 60 and 66 to allow the use of motors and to save in line inductive drop. The Niagara installation and the use of converters introduced 25 cycles and the projected use of series alternating-current motors has caused one plant to be designed for about 17 cycles. Many generators have been built for odd frequencies as 62.5, 50, 40, 33 and 30 p.p.s. Abroad 50 and 100 cycles are the common usage.

The most important characteristic of the alternating-current generator is its property of inherent regulation. With but few exceptions this largely determines the design. Formerly a large number of ratios were used to express this value, but it is now taken as the ratio of the increase in terminal voltage from full load to no load, with constant speed and excitation, to the full load voltage. Regulation is to alternating-current design what commutation is to direct, and many of the elements in both are common. The principal factors which affect regulation are a variation in the useful magnetic flux due to the demagnetizing influence of the armature; a distortion of the magnetic field, due to the cross turns, which changes the form factor of the induced wave of e.m.f., the reactance of the armature winding and the real and apparent resistance of the same. These quantities, with the exception of the armature resistance, vary with the power factor of the load and also, at any given power factor, vary through a cycle. Methods for predetermining the regulation have been developed simultaneously with improved methods for obtaining the same in the design of the machine. It is impossible to test large generators under actual load conditions before they are installed, and some method of calculation from test results is necessary in order to determine if the guarantees in this respect have been met. Also it is extremely important in estimating the conditions of excitation for different load and power factors.

The first method was to run the machine on short circuit and from a determination of the synchronous impedance calculate the fictitious value of the generated e.m.f. which gave the regulation, and, with the saturation curve, determined the exciting power. The next was to consider the magnetomotive forces obtained in this way, and to take the final e.m.f. from the saturation curve. A later refinement has been to separate the effects of self-induction from those of armature reaction, and to use a combination of the above methods. Many other methods have been proposed and discussed.

When used with reference to the particular type of machine, the above methods give more or less accurate results for non-inductive loads; the combined method, if good judgment is used in estimating the reactance, gives fair results for power factor loads as well, but after a large amount of discussion the subject is still in an unsatisfactory state.

The changes in design to secure good regulation have varied with different manufacturers. Some have distributed the winding while partly enclosing the slot, and use low reactions and a nearly straight saturation curve; low reactions bringing small exciting power but large iron sections and producing a heavy machine. Others use open slots with heavier windings on armature and field, a somewhat saturated magnetic circuit, and obtain thereby a lighter machine.

ALTERNATOR ARMATURE WINDINGS.

Early single-phase generators had all coils in series for 2,200 volts and the two halves of the armature in parallel for 1,100 volts. Some early polyphase machines possessed closed windings with taps brought out for the number of phases desired. Many two-phase generators were wound, as is present practice, with two single-phase windings each occupying half of the armature surface.

Three-phase windings are connected either star or delta. With the latter connection care must be taken to see that no pronounced third or ninth harmonics exist, which might cause a circulating current to flow in the short-circuited delta. This has never been found to any marked degree with inductor alternators, and where, in the revolving

field type, some current may exist, the design of the machine renders it practically harmless.

As in direct-current generators, alternators may have series or parallel armature connections. The coils may be connected in groups and these groups may be connected in either series or parallel. Naturally a large number of peculiar windings exist, but only the simpler ones have found wide application. The slot contains one or two coils and we have either a barrel or a chain winding.

Increasing outputs, necessitating larger conductors and the use of higher tooth densities, have brought about the use of rectangular stranded cable for armature conductors. This is sometimes used in conjunction with solid bars in the bottom of the slot. Square copper wire was developed for space economy and has had much use for armature windings. For many cases a special rectangular conductor of dimensions determined by the specific design, offers the best solution.

The early machines were wound for 1,100 and 2,200 volts. This was later changed in some installations to about 400 volts. Improvements in insulating materials and the desire to save the cost of step-up transformers have resulted in machines wound for all voltages up to 13,000, which is the highest standard in this country to-day; 6,600 volts are common practice for large installations and 13,000 volts are rapidly becoming so.

The design of alternators for parallel operation has been a recent advance. To provide means for quickly damping any oscillation is the element of success in devices which have been employed on the generator itself. The problem of such operation, while successfully solved, involves much besides the electrical relations. The latest European designs include induction and compensated machines of various types which are still in an experimental stage.

The great change which has taken place in dynamo construction is shown in the accompanying illustrations. Fig. 1 is Faraday's first experimental machine, and Fig. 2 the largest direct-current generator built—the 3,700-kw machine at Boston. Fig. 3 shows a revolving-field type polyphase generator with direct-connected exciter, built in France about 1880, and Fig. 4, a modern engine-driven alternator of 2,000 kw.

Reminiscences of Work on Electrical Patents.

BY EDWARD P. THOMPSON.

"Whatever the title may be, the subject matter always includes temperance," I once heard remarked about John B. Gough's noted humorous lectures. Similarly, whatever generic title is proposed to me, the specific title must be inventors or inventions. This time it will be both, by way of variety, omitting names, for fear their owners might possibly object.

First, I would like to tell about the narrow escape of a wealthy electrical inventor, who, when not rich, had informed me that he wanted to live in a $50,000 residence. He has since owned two such villas. While rooming with him in the same suite many years ago, I heard moaning and groaning, one night, and I found him only able to say that he was dying, and that, during the day, while experimenting with vacuum pumps, he had swallowed a few drops of mercury, by sucking on the end of a tube, terminating in that metal. "The tube was vertical and forty inches long!" he exclaimed, "and yet I thought mercury would rise only thirty inches, even by full atmospheric pressure." A little mustard cured him. The next day he engaged his patent solicitor to apply for a patent on the conception of a pump operating upon an alleged new principle, which was discovered by his being poisoned nearly to death.

Inventors are often in such a hurry to test an idea that they do not take the necessary time to collect and construct the proper apparatus. Incandescent electric lamp vacuum pumps were all the rage with inventors of a quarter of a century ago. I had occasion to visit one of our five most prominent electrical inventors. On my way to his laboratory I pictured to myself the luxury of the facilities that must certainly surround him. The amount of capital he could call upon was practically unlimited; his record as a great inventor had been long established, and he had been awarded many patents. I found him alone in a barren room ten feet square. The lamp bulb which was being exhausted (?) was suspended by a string from the ceiling. No carpenter had been ordered to construct a shelf to hold an iron reservoir containing about five pounds of mercury. No, the inventor held it up high with one hand while with the other he raised and lowered a tomato can full of that heavy metal. The glass tubes, mostly iron gas pipes—if I may perpetrate an Irish bull—had been patched together at a hundred different points by himself or some other amateur. "Crude, crude, crude," I said to myself. "Just trying to see if the principle is O. K.", he remarked, apologetically, as if he could read my thoughts by my expression.

The generosity of another one of the "Electrical Five" was almost incomprehensible. On one occasion I inquired casually what result would follow from certain technical speculations. "Try it," he replied, instantly. "It is all very well for you to say to experiment, but I have no adequate facilities," I responded. "Use my laboratory," he urged. "A week or more would be required," I answered. "Take as long as you please," he said. For ten alternate days, although a suit of clothes which became saturated with odoriferous red oxide of nitrogen in the chemical room had to be thrown away; although the smell of gas from the Bunsen burners in the glass glowers' department was rather asphyxiating; although not only my hands but my face became black in the tool room, and although the mercury vapor in the pump room was appreciably salivating, yet I was blissful.

Inventors and their backers sometimes appear ludicrous. I remember the sight we once created at an electric brake test, ten years ago, while we were riding through the country for a few hundred miles. The villagers and farmers stared, not only with wide open eyes, but with wide-open mouths, at a train made up of dilapidated and abandoned freight cars, dotted here and there, on top, by men wearing silk hats and frock coats. Contrasted with the freight cars was a new Pullman car in the middle of the train. More dress hats were on the locomotive—or more accurately stated, were on *men* who were on the locomotive. While still staring, the spectators witnessed an emergency stop, and glossy high hats flying through the air by their own momentum. In those days, only when all on board were knocked down, was the brake pronounced highly efficient.

The popular or non-technical mind is more observant in experimenting than we sometimes give it credit for. One day, while making some tests, my father appeared on the scene. I was adjusting the aerial wires and connecting up the wires between the relay, battery, coherer, etc., etc. The wires were long and snarled, and, therefore, were much in evidence. I thought he might be interested to know that all this paraphernalia related to wireless telegraphy, so I mentioned the fact. "Wireless telegraphy!" he exclaimed. "I never saw so many wires in my life."

I congratulate you upon the long and prosperous career of the ELECTRICAL WORLD AND ENGINEER. I measure my technical term by its life, for it was in 1874 that I entered Stevens. May many more years of usefulness await you.

The Unknown Nature of Electricity.

BY MAJOR JOHN MILLIS, U.S. ENG. CORPS.

To me the most impressive thought connected with the extraordinary advances that have been made in electrical science and in its industrial applications during the past thirty years is that the present state of the science and its related arts has been attained with so little knowledge of the real nature of electrical actions. This suggests the enormous strides in the number of practical applications, in the simplicity and economy of apparatus, and in general efficiency that are yet to be expected in case the mysteries of electricity are ever solved.

As to the progress in this direction during the last thirty years it must be said that it has not been especially encouraging. On the other hand, the newer manifestations of very recent times, or rather the interpretations and theories that have been engendered by certain recently discovered phenomena, seem to me to have befogged the subject rather than to have contributed to its elucidation. It is my belief and expectation that the time is not far distant when the extensive and somewhat confused collection of data regarding electrical as well as all other physical phenomena will be crystalized by a generalization of surprising simplicity. Neither abstract mathematical research nor complex and illogical assumptions regarding the nature of matter will, in my opinion, point the way to the ultimate solution, but the basis for such solution is to be sought in principles that will appeal to the human intellect as simple, practical and consistent. I regard the acceptance of such a general theory for all phenomena of matter as likely to mark the beginning of the next most important period of practical electrical development, and I have not yet seen the announcement of anything that looks to me as likely to indicate directly the development of such a theory.

The Growth and Influence of Electrical Industries.

BY C. A. COFFIN.

On the occasion of the thirtieth anniversary of your paper, the establishment of which was the genesis of electrical journalism in the United States, it is interesting to review this period, during which the growth of your journal has kept pace with the wonderful development of a great industry. The great ability and candor with which you have ever recorded the achievements and stimulated the activity of all workers in the field of electricity has been a potent force.

In 1874, practically the only commercial piece of electrical apparatus in use was the simple Morse telegraph, followed immediately by the duplex and Edison quadruple instruments. While the arc lamp, the telephone and the incandescent lamp had all made their appearance a few years earlier, it was not until 1886 that the electric railway motor came to be regarded as possessing commercial possibilities. Thus, springing from an experimental laboratory, there have, in twenty-five years, been developed industries which in the last year alone have produced over $150,000,000 in manufactured articles. That this development is still going on with unabated enthusiasm on the part of the engineer, inventor and manufacturer is an ample guarantee of continued growth and of more varied uses of the electric art.

New designs of apparatus and devices, embodying physical phenomena unthought of even four or five years ago, continue to surprise those intimately associated with the industry, no less than they surprise the public. During this evolution there has grown up a class of young engineers, chemists and physicists who form a body of trained minds unique in the world's history. There certainly is no other field of work where the element of scientific knowledge is so influential and essential as in the multifold applications of electricity.

The producers of accessory apparatus and material have been forced to come to the electrical standard. To the electrical engineer is largely due the present excellence of the gas and steam engine and of hydraulic machinery. The maker of iron and steel has better learned his product and has brought it to the present high quality largely through the requirements of the electrician. The present wonderful development of the steam turbine, in whatever form, has been stimulated by electrical requirements, and but for these demands it would be far less advanced than it now is.

It has been your good fortune to record the discoveries and the growth of the industry, and to encourage it vitally these many years. That such a function, so well performed, has been of the highest value, none can question, and I express the sentiment of all who have watched your career, in wishing that your next thirty years may be a witness to and a part of continued progress in the development of the electric art.

Twenty-four Years in the Edison Lamp Factory.

BY JOHN W. HOWELL.

When Mr. Edison concluded that a successful lamp should have an enclosing globe made entirely of glass with all joints fused, the corollary which at once presented itself to his mind was that the lamp must be so durable and so cheap that when it failed it could be thrown away. When the Edison Lamp Company was organized Mr. Edison fixed the price of lamps at 35 cents, knowing that the lamp would cost more than that until suitable manufacturing methods were developed. This development has been going on for twenty-four years, and still there is work for the engineering department of the lamp works.

In this newly-created industry all operations were done by hand by more or less skilled labor. Now machine methods are quite general. The making of carbon filaments and the making and assembling of the glass parts were entirely new operations. No machines existed which could be adapted to the work. The machines had to be originated and developed for this work, and they have been. This statement is nothing like so impressive as is seeing the machines by one who was familiar with the work as previously done by hand.

The exhaustion of lamps by mercury pumps required from four to six hours in 1881. Improvements in pumps and methods reduced this to ½ hour in 1895. Since then by simple piston pump and "chemical exhaust" a much better result is produced in one minute. The cost of exhausting a lamp at the end of 1882 was considerably greater than the total cost of a lamp at the present time.

All the glass working operations have been changed from hand work by "glass blowers" to machine work by unskilled labor. The labor cost of the principal glass operations is now a little more than 10 per cent. of the cost in 1882.

Until 1894 all our filaments were made from bamboo, each piece passing through eight separate hand operations. Now squirted cellulose is used. In this department we now employ 83 operators. If we should go back to our bamboo fibre we would require over 2,150 operators for the same production.

Photometric methods and apparatus have been wonderfully improved and developed. The cost of photometric measurements is now 9 per cent. of the cost in 1882 with a great gain in accuracy.

The lamp of 1880 contained at least 30 times as much platinum as the lamp of the present day. The amount and cost of glass and other materials used have also been greatly reduced.

The greatest production reached in the Menlo Park Lamp Factory in 1882, was 1,000 lamps in a day of 24 hours. The present production of lamps by the General Electric Company is 100,000 lamps a day of ten hours. To produce these requires about 3,800 employees, of whom 80 per cent. are girls.

The lamp of to-day is very much superior in quality to the lamp made in Menlo Park, a great many improvements having been made by careful attention to small details of manufacture, while some very considerable steps in advance have been the results of careful investigations of phenomena observed in the processes of manufacture, and the adoption of new processes or methods.

The lamps made at Menlo Park for the steamship *Columbia* consumed about 100 watts for 16 candles. To-day the standard 16-cp lamp consumes 50 watts. The useful life of a 50-watt lamp to-day is undoubtedly longer than was the useful life of the 100-watt lamps of 1880, and while we have no data for a correct comparison showing the improvement which has taken place, we can get a good idea of it from the fact that the estimated useful life of a 100-watt, 16-cp lamp made to-day is over 10,000 hours, which is about as many times the probable useful life of the 1880 lamp as the number of elapsed years.

In the future I believe this multiplier will greatly exceed the number of elapsed years, for I have entire confidence in the fitness of the carbon filament to maintain its place among artificial illuminants.

The Slowness of Storage Battery Evolution.

BY ROBERT MCA. LLOYD.

In reviewing the scientific literature of the last twenty years one is impressed with the vast results recorded to the credit of investigators, engineers, manufacturers and energetic business men, but perhaps we may lose sight of the fact that in this period an immense amount of work has been done of which no account exists. Many great researches have been prosecuted for definite purposes which were unproductive of results of commercial value or scientific interest and, therefore, not reported. And many able men have wasted their time and resources in fields that have proven barren or in the study of problems that remain unsolved.

There are other fields in which great efforts have failed to achieve the success hoped for, but where enough has been accomplished to form the basis of commercial operations of some importance. The storage of energy and electrical energy in particular began to attract a great deal of attention about twenty years ago, and a continuous search has since been made for materials in which and methods by which this energy may be accumulated and reserved for future use. Life, reputation and treasure have paid dearly for the development of the storage battery of to-day, about which has grown up a thriving industry in Europe and America; but it can hardly be said that the goal for which electrochemists were striving twenty years ago has yet been reached. Research in storage battery science is slow for the reason that months and years are necessary for many of the experiments. The test of time is also paramount in every application of storage batteries to commercial purposes, and while there is every reason to expect great development in this branch of electrical science and industry during the next twenty years, the rate of progress may still seem slow to the readers of this journal.

I cannot send my congratulations to the ELECTRICAL WORLD AND ENGINEER without expressing my warm regard for its personnel, and the hope that the electrical fraternity will continue to have for at least twenty years more the encouragement and comradeship of its present editors.

Fifteen Years of Electric Heating.

BY JAS. I. AYER.

MY participation in this work covers a period of a little more than twenty years, beginning at a period when incandescent lamps were little more than toys, and the arc lamp had reached a stage where we could cheerfully assert that the last lamp on the circuit would burn as brightly as the first, no matter how long the circuit; and that it required but two-thirds horse-power per lamp for their operation.

To the confiding investor it was later necessary to explain why a 50-hp engine was fully loaded driving a 40-light dynamo operating 30 lamps, and he was told that the horse-power consumed by the lamp was electrical and not the indicated horse-power of the engine. It was then clear to the lay public that the mysteries of electricity were not to be compared with anything which had come within their ken before.

To-day when we have children entering college who do not remember any other than the incandescent light in their home, the pater stands by watching the electric meter correctly record on the dial exactly the number of lamps that are being operated under his own observation by the innocent electric meter, which has developed such an extraordinary bill. He then realizes that the mystery of electricity is as great as ever.

The remarkable expansion which has taken place, showing practical so many new applications and methods that by wise leaders from time to time were condemned as impossible or impracticable, seems to leave no just ground for any one to predict any limitations of the expansion in the future. It is curious in looking back to find how few of any proposed electrical branches have failed to make good. This to me is the most remarkable element of the history of this wonderful industry. In almost every instance the toys and condemned theories have become important elements of useful application. There is hardly a proposition in the way of a new development that was considered at all seriously that I can recall, except the development of electricity direct from coal, that has not justified itself.

Electric heating attracted attention about fifteen years ago, and first efforts were met with that hearty loyalty characteristic of the public to everything electrical, and its successful development was frequently pronounced on hearsay only as an accomplished fact by the average electrical "expert" in his usual optimistic way when appealed to. He could not afford to admit his ignorance; and it was safer to endorse the claim. All of this resulted in securing favorable consideration for the early elementary products created in a new field, at a time when the demands in the older developments for both men and money, far exceeded the supply. The result of feeble efforts with crudely made products, coupled with the then high cost for current, was a general impression, very firmly established, that electric heating apparatuses for general domestic and factory applications were delicate, expensive toys, which, even if they could be improved and made sufficiently good, were impracticable because of the cost for operation.

This swing of the pendulum was wide, and when the development of the industry was taken up more seriously the debris of this advance guard formed obstacles quite as serious in securing the ear of the public as had to be overcome in preparing a more suitable and logical product to offer them. Electric heating is one of the last of the early developments to "make good," but in the past few years it has made good, and to-day, while it has firmly established itself and gained its place in the line of permanent electrical industries, its broad and extensive development is just about beginning.

While the number of electric heating units in daily service runs into many hundred thousand within the next few years the contrast with results developed to-day will be insignificant. It has been a slow process putting into service thirty or forty thousand flat irons to smooth the way for the work that is to come, but it is something of a triumph to put twenty thousand stoves at work baking as many thousand crackers every five minutes, developing thereby a product that could be produced in no other manner, and yet doing it at a cost that puts it on a par with other methods for turning out such goods.

The complete and elaborate equipment of the large Government Printing Office in Washington for all special heat requirements, and similar work in a great variety of establishments in other lines, are the foundation stones for the beginning of as broad a development in this line as the application of the electric motor if not greater.

Reminiscences of the Universal Exposition of Electricity in Paris, 1881.

BY PROF. HENRY S. CARHART.

The Paris exposition of electricity in 1881 was notable for many things. The first international Electrical Congress was held in connection with it, and this congress stands out in the history of electricity both on account of the eminence of its members and the results of their deliberations. It will be recalled that the theoretical definitions of the ohm and the volt were confirmed by this congress, and that it added the ampere, the coulomb and the farad. These units went into immediate use, and the International Committee charged with the determination of the length of the thread of mercury one square millimetre in cross section and at a temperature of zero degrees Centigrade, which should represent in material form the resistance of the ohm, immediately began its work.

The personnel of the congress, which was composed of official delegates assembled under the auspices of the French Government, was no less notable than the work done. It included many names which stand forth with great prominence in the annals of electricity. There were Clausius, Helmholtz, Hittorf, Kirchhoff, Siemens and Wiedemann, of Germany; Ayrton, Latimer Clark, Crookes, Dewar, Hopkinson, Preece, Rayleigh, Kelvin and Tait, of Great Britain; Becquerel, Cornu, Fizeau, Bouty, Joubert, Lippman, Mascart, Planté and Violle, of France; Rowland, of America, and Ferraris, of Italy. Alas! How many of these have since died.

The Paris Exposition of 1881 was notable also for its exhibits. It was the period of the inauguration of great electrical industries. One recalls first, perhaps, the exhibits in incandescent electric lighting. The Edison "system" was there, of course, "Jumbo" and all. Who had the temerity to predict at that time that in little more than twenty years we should see grow out of this as one of the chief contributing streams the present General Electric Company. When one compares the Edison "Jumbo" generator of the Paris exhibition with the direct-connected generators of the present, of 5,000-kw capacity and upwards, he is impressed with the rapidity of the evolution that has taken place, not only in size, but still more in scientific and technical development.

When the youth of to-day hears of Sir Hiram Maxim and his fame derived from the design and manufacture of rapid firing guns, he is hardly prepared to read that the inventor of the Maxim system of incandescent lighting at the exhibition of 1881 was indeed the original of the present Sir Hiram. He was then a plain aggressive American; he is now a knighted English subject. The year 1881 may be properly described for him as the period when "knighthood was in flower."

In 1881 the storage battery was in its infancy. Faure had just produced a great sensation by sending a storage cell to Sir William Thomson, who had made a rather startling report about it. In the Palais de l'Industrie were the exhibits of both Faure and Planté. Among my recollections of the distinguished men at the exposition none are more delightful than those relating to that charming French gentleman, M. Planté. His memory should ever be kept green as a pioneer scientific worker of exceptional value.

Perhaps the exhibit which one recalls now as "bahnbrechend" above others was the electric railway installed and exhibited by Siemens & Halske. It was indeed only a few hundred feet long, and the connection of the car with the trolley wire was of a very primitive and uncertain kind. The under-running trolley wheel was an invention of a later date; still the exhibit contained the germ of the modern electric railway in the early stages of development.

Such an exhibition has a large value in the dissemination of new ideas. The seeds of invention are there thrown to the winds and are carried to the four corners of the earth. The Paris electrical exhibition was the beginning of the new era, both in the science of electrical measurements and in the technical applications of electricity. We look back to it as the day of small things electrical, but it was in reality the day of large and brilliant ideas.

Past, Present and Future of Electric Traction.

By Frank J. Sprague.

On an anniversary one may become reminiscent. 1874, the year of the birth of the Electrical World and Engineer, has for me a special interest, for although I had set foot on this planet about the date of the laying of the first Atlantic cable, it was then that as a cadet at the United States Naval Academy I began the professional career which ended in the electrical field, when I resigned from the service in 1883 to become one of Mr. Edison's assistants. A prolific period this, and one in which the Electrical World and Engineer has been an effective recorder, tutor and encourager. Of what has been done in many electrical fields others can tell much better than I, so I will speak in brief fashion of but one subject—some features of the development of electric traction.

Although when the Electrical World and Engineer first went to press, a quarter of a century had passed since Farmer and Page had carried on their experiments with small model electric railways, there was not in existence a single car operated by electricity. Five years later Edison had in his development of the incandescent light created the low-resistance dynamo and established the multiple arc system of distribution, but even after eight years more elapsed there were less than a dozen electric railways the world over, scarcely any two alike, and none typical of the modern development, to mark the work in this line of such pioneers as Siemens, Henry, Edison, Van Depoele, Reckensaun, Daft, Field, Bentley, Knight and others. Perhaps the time was not ripe, and it needed a special combination of opportunity and willingness to assume the great commercial risks, as well as a departure in practice profiting by the mistakes of earlier work, to start that industrial progress which has been so astounding. Such an opportunity occurred at St. Joseph, Mo., and more especially at Richmond, Va., in 1887, when, under the auspices of the Sprague Electric Railway & Motor Company, which had been largely fathered by Edward H. Johnson, and adopting a principle of motor construction and suspension tested by me on the New York elevated railroad the year before, the active commercial development of the electric railway began.

The vicissitudes of the Richmond road have passed into history, its apparatus into honored and well-earned rest, but the principles underlying its construction and operation have survived, and to-day mostly dominate all electric traction, for there was used the multiple system of distribution at constant potential of 400 to 500 volts, the single overhead trolley with parallel main conductor and feeders, the ground return with bonded and reinforced rails, the universal movement underrunning trolley carried in the center of the car, double motor equipments under the car, centered on the axles, geared to them and flexibly supported at the free end, fixed brushes for both directions of movement, variation of current and torque by variation of field resistance and turns, dual control of motors, and series and parallel operation. While novel, all these features were not original with Richmond. Edison and others had used constant potential, Van Depoele form of underrunning trolley. I had proposed a rigid overhead conductor with flexible overhead contact for the Metropolitan Railway in London, in 1882; and Reckensaun had put into operation series parallel control; but many features were distinctly new there or in the preliminary experiments of the Sprague Company, and at Richmond there was the combination of various ideas old and new on a scale commensurate to achieve results.

While that work was in progress the Van Depoele Company was offered me by Mr. W. J. Clark, whose commercial sagacity and effective work in the development of electric traction has been so many times exemplified, and on my failure to take it up (I could not) it fell to the Thomson-Houston Company and Mr. Coffin. Aided in a great measure by Van Depoele's happy adoption of the carbon brush, and with unusual business energy, the Thomson-Houston Company rapidly developed. The resulting rivalry and warfare between it and the Sprague Company, although not unattended by some disastrous results, on the whole was of ultimate great benefit to the art because of the rapid development of apparatus and the extension of electric traction. In 1890 came the absorption of the Sprague Company by the Edison General Electric, with which it was allied by financial and manufacturing interests, and later the union of it with the Thomson-Houston in the General Electric Company.

At Richmond, it should be noted, began the contest between the electric railway and the telephone interests because of the common use of earth and rail returns, with resulting injurious effects on the weaker and more delicate apparatus. This was waged in not less than sixteen States of the Union, with the practical result of the adoption of complete metallic circuits for the telephone system—a result the necessity of which was already beginning to be apparent, and which was later emphasized by the growth of long-distance telephone service, quite independent of the influence of electric railways, who were not the sole distributors of peace and—potential.

A decade passed and the trolley hummed its song of victory and emancipation while weaving its threads in every civilized country. Horse, mule, cable and prejudice disappeared, towns became cities, farms became suburbs, homes grew up in the place of tenements, time and money were saved, the health and morale of employees were improved, great works were created, and an army of men were employed. Companies were consolidated into great systems, as under the initiative of Henry W. Whitney on the West End of Boston, and hundreds of millions of capital were invested.

But with it all the trolley remained essentially an individual system, the movement of single cars along highways, picking up and leaving passengers wherever desired, its use largely determined by convenience, capacity and economy under such conditions, save in a few instances of limited train movement where the power was consolidated in a single car at the head of a train, a kind of equipment in fact on which work was progressed as early as 1885. The steam railway field on its own exclusive right of way was practically uninvaded, although as early as 1892-3 the construction of a locomotive for experimental work for Henry Villard had been undertaken by Drs. Louis Duncan, Cary T. Hutchinson and myself; and the General Electric Company had actually undertaken the contract for operating the trains through the Baltimore tunnel. But conditions where electricity could be applied on such a scale were limited.

In 1897, however, just ten years after the Richmond beginning, an opportunity again arose for a development which may also be fairly termed epochal. For a dozen years the Manhattan Elevated Railway Company had been the objective point for electric enthusiasts, and for nearly two years I had endeavored unsuccessfully to get an opportunity to make demonstration there at my own expense of a new system which was the outcome of the electric control of elevators. The proposed equipment of the South Side Road, of Chicago, under the technical advice of Sargent and Lundy, the latter of whom had been with me in the early work, afforded the opportunity I sought, with the result that the multiple-unit system was contracted for, and before the end of the year tested at Schenectady and Chicago.

This system did not consist simply of a method for single control of motors on different cars of a train, for that had been proposed many years before by others as well as myself, but for grouping into a train two or more motor cars, each equipped with motors and controllers for those motors, with provision for simultaneous control from master switches of all the main controllers through the medium of an independent electric train line common to all the cars, and connected on the one hand to the master switches, and on the other to the operative parts of the controllers of several equipped cars. The connections from car to car were made by jumpers, and the main current for each car was taken by collectors on that car. The train connections were such that cars could be made up into any desired aggregation, without regard to number, order or relative relations. As originally planned (and the original equipment is still in operation) the main controller was of the cylinder form, with pilot motor drive. Stepped or automatic advance under current limitation on each controller was obtained by relays operated from the train line. Since then the multiple unit idea has grown and spread until it is now almost universally adopted for all heavy work. Many variations in detail have been made from time to time by different inventors, such as operating the cylinder by air pistons or magnets instead of by a pilot motor, or breaking up the controller into different parts, each operated by a magnet or air piston, with or without automatic control, or with the automatic feature limited to the main switch. But the essential principle—the electric control of the controllers from master switches through an independent line—has never been and is not likely to be, departed from.

From combining and operating car units equipped with motors aggregating a capacity of 100 hp for passenger service only, the practice has now developed until it is applied to locomotive operation.

The 2,200-hp units which are to form a part of the New York Central Railroad equipment will be so operated, giving at times a possible aggregate of nearly 7,000 hp under single control! It is here in New York that two of the greatest improvements are now being carried out which will have a marked, although perhaps specialized influence on electric traction. I refer, of course, to the great work of the Pennsylvania Railroad Company, and the even more extensive electric undertaking of the New York Central—the latter of which is actively pushing, in connection with its terminal changes, the electrical equipment of its regular main and suburban service for nearly 40 miles out from its city terminal, where the heaviest trains will be operated at the maximum speed.

The plans adopted for this equipment, decided on by a commission of which Vice-President Wilgus is chairman, include the use of continuous-current motors within the zone to be equipped, a decision of perhaps more than ordinary moment at a time when world-wide experiments are being undertaken, and extraordinary claims made, in behalf of alternating-current motors; and one which warrants some comment both upon the special subject of such motors and the electric operation of trunk lines in general.

The present is not the time for me to go into any detailed statement of the reasons which were conclusive for the commission's decision, but suffice it to say that I am entirely satisfied with it, and believe it was the only one which could have been safely reached at the present time. This is said without any spirit of antagonism to the alternating-current motor development, and without abating any jot of confidence in, or hope for, its future. Certain statements, however, I think, can now be safely hazarded: One, that the polyphase motor will not secure any lasting foothold in railway operation; another, that the continuous-current motor will not for a long time outlive its usefulness; and finally, that trunk line electric operation as such is not of the immediate future.

Machine for machine, the commutatorless motor, coupled with the ability to economically transmit electricity at high pressure for a great distance and transform with stationary apparatus to any desired pressure, has been matched against the limitations of the commutated motor and restricted distribution for the 15 years since Ferraris and Tesla first advocated its use. Polyphase transmission has become a most influential factor in long-distance transmission, and the polyphase motor finds a wide and increasing field of usefulness; but the continuous-current motor still performs its service placidly and demonstrates its utility, while throughout the United States there is not a single polyphase railway, and in Europe there are but a few introduced, chiefly by a single company of great technical ability.

Within the past year, however, undoubtedly spurred on by Mr. Bion J. Arnold's predictions and pioneer work, the leading companies in this country have made material progress in the construction of single-phase alternating-current motors, and similar developments are taking place abroad. Probably in no phase of the electrical development has there been greater concentration of high technical skill and mathematical ability than in this new departure by such men as Steinmetz, Lamme, Finzi and others. The methods and results vary materially, but one significant fact is patent in all—the much-despised commutator has reappeared, and under conditions some not as favorable as exist in the continuous-current motor.

In all alternating-current motors there must be a reduction of armature potential if high-potential transmission on the trolley exists, either by short-circuiting a closed armature with independent circuits in a field supplied direct by high potential, as in Prof. Elihu Thomson's repulsion motor, or by transformation of the whole or part of the current energy, as in the Lamme and other motors. In some cases even a greater number of brushes is used than in continuous-current practice. At present the latter type of motor apparently has some advantage in the matter of weight, individual efficiency and freedom from sparking, and I think will maintain it. Undoubtedly, however, the future holds out much promise for the single-phase motor, and it will be a satisfactory machine. It is well, however, to ask wherein lies the demand for it, and why does it threaten the supremacy of its rival? There are two special reasons remaining, that one on which much stress was laid, the absence of commutator, no longer existing. These are the possibilities of use of a fairly high potential on the trolley, or secondary system of distribution, with resultant increase of distance between the substations and better averaging of load on them, both very important features, and the abolition of the rotary converter, a desirable result. But as to the first there is a chance for error of judgment, for the possibilities of the direct-current motor are by no means exhausted, and for any given maximum potential and track rails specific resistance continuous current admits of the less size of conductor.

In the matter of initial transmission to sub-stations, the advantages of high potential are common to any system of motors. At these points the pressure must be transformed down, the energy being then delivered through rotaries or motor-dynamo sets for continuous current or direct for alternating current to the seconday supply system.

Up to the present it has been the general practice to limit direct-current work to about 600 volts partly for construction reasons and partly because of the existing practice on city systems, or at terminals, where the alternating current is used at 3,000 volts. It would appear at first sight that with the same size of conductors and loss increase of pressure would mean an even greater increase of distance between sub-stations. Since, however, the load on the secondary circuit would increase about as the distance between the sub-stations, and the capacity of the secondary circuit would probably be considerably less than that of the ordinary third rail because of the necessity of carrying smaller conductors over the cars, even if such conductors are reinforced, as would be most advisable, by a main conductor extending along the tracks and supplying the trolley wires parallel to it, the distance between the sub-stations would be materially reduced, and in fact would generally be considerably less than that represented by the simple ratio of the increase of potential.

While direct-current motors may be always somewhat at a disadvantage in the matter of individual potential, when there is a plurality of motors, as in a large locomotive, it is quite possible on a direct-current system to work up to 1,700 or even to 2,000 volts on a single trolley line, maintaining a maximum as in regular use on the Berlin Elevated of from 850 to 1,000 on individual motors; and if a three-wire system be used it is quite possible to make use of a maximum transmission potential of nearly 4,000 volts. I am not prepared to say yet that this is advisable, but it is possible and I submit that in the problems involved in any trunk line development there are many questions of greater importance than that of the relative allowable trolley potentials for direct and alternating-current equipments.

The very essence of successful electric railway operation has been to supply from a single source of power a large number of moderate powered and well-distributed units. Trunk line service is of quite a contrary character, and many of its present features must be changed, or its density of traffic greatly increased before investment necessary for electric operation can be generally considered. It may be accepted as a cardinal principle that no large railway system will generally adopt electricity as a motor power unless it be dictated by the assurance of less cost of operation or a greater return on existing and new investment, and such adoption will not take place until the average density of traffic will warrant the operation on a section measured by the practical limits of transmission from a single station, at which time the joining together of sections will become possible. Infrequent and spasmodic service in large units over long distance offers little chance for electric operation. The early application to the large locomotive units will be in such zones of electrical operation, like the New York Central, where the pressing use of electric suburban service and other special requirements, exist, under which cases all equipments should be electrically operated. Such cases are, however, specific, and are not necessarily favorably conclusive on the larger distance proposition. On this subject I see no reason to change my views as expressed at length many times during the past fifteen years.

Flat Wheels.

The New York State Railroad Commission has recently reported on its work with regard to improving transportation facilities in Manhattan and Brooklyn Boroughs. The operation of cars with flat wheels causing annoyance to residents by the noise has been taken up with the various companies and a more thorough inspection and removal of flat wheels has been ordered by the Board. During the quarter ending November 30, 1,367 pairs of new wheels were placed under the electric cars of the Interurban Company. During the same period 1,659 wheels were placed under the cars of the Brooklyn Rapid Transit Company.

The Dissappearance of Overhead Wires.

BY W. MAVER, JR.

While it is true that electrical subways for the use of high and low-tension cables were in use in Chicago, Philadelphia and elsewhere on a comparatively small scale before their employment was begun in New York City, nevertheless it was in the last-named place that the problem as to whether it was feasible to operate high-tension circuits commercially, and on a large scale in cities was to be solved. That this was considered a problem by many at the time in question, 1886 to 1890, will be evident from the fact that some of the men then most prominent in scientific circles were willing to place themselves on record as being of the opinion that it would not be possible to operate such circuits underground. If, said one of those men in a portion of his argument, the conductors are lead-covered to enable the insulation to withstand the destructive influences of moisture and gases present in these conduits, the trouble is only mitigated, for the lead covering is itself subject to corrosion by the same agencies of moisture and gas. As soon as by these means, or by such abrasion as is liable when the lead-covered cable is being drawn into the conduit, or by a defect in the manufacture, the lead pipe is punctured, moisture will soon exert its injurious effect upon the insulation. Besides, with current of high electromotive force there is always present an action of polarization of the insulating material which tends to change its structure and cause the formation of faults in it, which, with other things, would make the difficulties of operation insuperable.

Some of the high-tension companies were at the time willing to place their circuits underground, others professed to be willing to do so, but insisted that the civic authorities should, by actual tests, first show that it was practicable to operate high-tension circuits underground, claiming that the attempts in this direction in other cities had resulted in failure.

The rules that were promulgated for the operation of the high-tension cables in the city were also objected to vigorously by the dissentient companies, especially the rule requiring that the cables should be shown to possess an initial insulation resistance of 15 megohms per mile, per 100 volts e.m.f., it being asserted that this could not be obtained in practice and, if it could be, it would be impracticable to make the tests to demonstrate the fact. Said the same authority, the measurement of 100 megohms with the apparatus ordinarily used for the measurement of resistances is a very difficult operation and requires not only a very high degree of skill and the most sensitive and finely adjusted instruments, but it is essential for even tolerable accuracy that the instruments should be free from all disturbing influences and used under conditions which are rarely formed outside of the best equipped physical laboratories.

So far as the making of the necessary tests is concerned, the present writer may modestly say, inasmuch as he either made or supervised the thousands of tests of the cables that were laid in New York subways for a number of years thereafter, that it presented no great difficulty. It may be noted, however, that at the time in question and as showing the dearth of practical electricians then existing, that Mr. G. A. Hamilton, Mr. D. W. Jones and the writer were perhaps the only available experts in New York City for this class of work. The fact that such was the case may be credited when it is stated that the writer was engaged jointly by the cable manufacturer, the purchaser of the cable, and the subway company, to test for them the first high-tension cable that was laid in these subways.

There was at the time under consideration no exact data relative to many of the conditions to be met with in actual practice. Thus the thickness of insulating wall necessary for high-tension cables was not definitely known, and hence some of the first cables manufactured were deficient in this respect, the mechanical strength being insufficient to meet the strains of hauling in, bending, etc., to which the cables were subjected in practice. The writer was fortunate enough to specify in one instance a thickness of insulating wall of .25 in. for a cable designed for 7,000 to 10,000 volts, a thickness which subsequent experience has shown to be ample. The proper size of manholes, handholes, etc., was also an unknown quantity and as a rule they were in numerous cases made too small, a defect which has been remedied in later years. A few months' experience, however, sufficed to throw much light upon all of these questions, and as fast as possible improvements were suggested looking to the betterment of the service. Among these was the use of beveled edges at the entrance of the ducts in manholes to prevent the cutting of cables; the placing of switches on posts or on walls outside of the subways to which switches the cables should be led for purposes of testing, changing circuits, etc., which plan was adopted in the case of the fire department cables and some of the electric light companies, and might be extended further to advantage.

Reverting to the rules relative to the testing of cables, it is but fair to add that these rules were probably drawn purposely rigid as a precaution against the dangers of explosions in the subways. It was a more or less open secret at the time that the opposing interests would subject the cables to the severest tests to demonstrate the accuracy of their contention as to the impracticability of high-tension underground systems, and obviously counter precautions were taken by those financially and otherwise interested in the success of the subways; and to-day no one questions the wisdom of that course.

Early Automobiling Reminiscences.

BY OBERLIN SMITH.

My chief experience in electrical matters (since spending much time when a boy in manufacturing a variety of what was then called electrical apparatus, for my own amusement) has been in the line of motor-driving of machines, especially power presses. As some of the readers of the ELECTRICAL WORLD AND ENGINEER may have noticed, I have for several years been an earnest preacher, in the various engineering societies and elsewhere, upon the subject of individual driving. This system, as opposed to the mere coupling of motors to long lines of shafting, or to group-driving, so-called, has passed the successive eras of crankiness and of doubtfulness, and has, mostly within the last two or three years, established itself as the paramount system of the future. Its advantages are too numerous to be repeated in this article, but I venture to predict that very few of the first-class newly-built machine shops of five or ten years hence will contain much, if any, shafting and belting.

Passing over the tremendous and obvious developments which are bound to occur in the near future in electric lighting, power transmission, high-speed railroading, etc., and also the glorious development which many of us see with prophetic eye in the not too far off future regarding the transmutation of heat into electricity, a nearby and very practical line of development lies in the improvement of the storage battery. This will vitally affect the running of automobiles and small pleasure boats, most of which are now run by their owners and chauffeurs under conditions of martyrdom, tempered by a spirit of self-sacrificing cheerfulness, which it is difficult for their friends to appreciate. When a mere layman in this motoring amusement, or art, or whatever it may be called, contemplates the tangled mass of tanks, and cylinders, and pipes, and rods, and screws, and what not, together with the tool outfit for adjustment and repairs, he can but sigh for the time when the electric carriage and boat will prevail, at any rate for purposes of business and pleasure.

To bring about such halcyon days of pleasure travel but two important new conditions are necessary. The first is to have a cheap, light and durable storage battery. The second will consist in the establishment of a system of electric charging stations at proper intervals, upon all our streets, roads and waterways which are suitable for the kind of travel we are considering.

It goes without saying that, upon the whole, we must have throughout our country a tremendous and radical improvement in the quality of country roads. This, however, is sure to come as the use of automobiles increases. It has been already developed somewhat by reason of the invention of the bicycle. Such charging stations should be regulated in some way by state or national law, in connection with the control of highways and waterways, to prevent extortionate prices; and thus will be enhanced the volume of travel and the development of the quantity and quality of the vehicles used therefor.

New Jersey's greatest inventor has taken up the first problem mentioned, with already a considerable measure of success. This it is hoped by all of us will soon ripen to complete fruition. We Jerseymen further hope that a State which has so large a field of travel, and which has already made such progress in good roads construction, will be one of the first to establish the charging stations in question.

While speaking of New Jersey (remembering the editor's invitation for reminiscences) I am reminded that I myself may have aided the progress of automobiling by showing how *not* to do it, I being perhaps one of the earliest chauffeurs in the State, or at any rate in the southern section thereof.

Upon a certain occasion over forty years ago I entered into an autoing collaboration with another boy, who is now a distinguished professor of mathematics, both being fired with enthusiasm to emulate the recorded performances of the occasional steam carriages appearing in England from Sir Isaac Newton's time into and through the eighteenth century.

Instead of building such a vehicle entire, the boys procured a farm engine of about 5 hp built in the general style of a steam fire engine, that is, with a vertical boiler at the rear, fired from behind, and a horizontal engine lying upon the framework in front. They soon realized the difficulty of steering by swinging the front axle with sufficient power and delicacy should either wheel strike an obstruction. This they overcame somewhat ingeniously by fastening ropes near each end of the axle, which came upward and rearward to the main shaft of the engine, being wrapped loosely two or three times around the same, on the principle of a "snubbing post." These ropes continued upward to the hands of the steersman, and with them he could control the axle perfectly by tightening one or the other more or less, the power to hold it against obstacles at either wheel being, of course, supplied by the engine as a rope tightened upon and grasped the shaft thereof.

Upon the first trial one of the rear wheels was connected with the engine by a wide belt running from a small pulley on the end of its shaft to a very large one bolted to the spokes of the wheel, which thus served as the only "driver."

In their haste to get the machine under way they waited not for good weather, but started upon a rainy day with the ground covered with slush. The belt soon got wet and the "auto" was held up for repairs.

For the next trial a chain and sprockets (not easily procurable in those days) were substituted for belt and pulleys. The machine itself ran well in spite of having only one driver, but, time still being precious in the eyes of the adventurers, the next start was made over a very bad road covered with snow two or three inches deep. This road was narrow and crooked, soon reaching a narrow wooden bridge spanning an icy river, then running up a hill at a moderate grade. To avoid delay, no connection was made at this first trial from the throttle valve (an ordinary 1¼-in. steam cock) at the rear of the boiler to the driver's seat in front, where he might have attended to it had not both hands been busy with the steering ropes, and both feet with bracing himself to keep him in his seat.

The professor was kindly allowed the honor of the first trial and when duly mounted yelled to the small boy who acted as fireman (standing upon the ground) to turn on steam, which then stood at high pressure. Being both obedient and strenuous, this youngster revolved the cock handle suddenly through an arc of some 90°, then letting it slip off and fall hidden in the snow as the machine bounded forward and left him standing in amazement at the ambition thereof.

Your servant, who was acting as general traffic manager, rushed into the shop ("garage" should it not have been termed?) wildly searching for a monkey-wrench and triumphantly emerging in chase of the lost auto car, which the powerless chauffeur had by that time succeeded in steering at full speed around the turns of the road and between the railings of the bridge—rather than down a steep bank into the river below. As he reached the hill beyond, with the car ascending and the steam pressure descending, the monkey-wrench and the boy he left behind him succeeded in reaching the steam-cock, and everything ended happily.

The machine not afterwards proving comfortable enough for a touring car was classed in the grade of runabouts, in view of the performances it had performed. Later on it became a stayabout.

Street Crossing Signal.

Mr. C. L. Cole, U. S. Consul-General, Dresden, says: "I notice the trial of a new safety device at street-car crossings in this city, which may be described as follows: A box 2 ft. long and 1 ft. wide is suspended from the wires at the center of the crossing, and at a certain distance the approaching car automatically turns on the current and from the opposite sides of the box is shown in red letters the word 'Halt,' to warn the car coming at right angle as well as teamsters and pedestrians. When the car reaches the center of the crossing, the light is extinguished. Watchmen are placed at all crossings in this city where cars meet, but I am told this device is being tested with a view of avoiding the expense."

A Historical Sketch of International Electrical Congressess.

By Dr. A. E. Kennelly.

THE history of electrical congresses dates from the year 1861, and the development of the power of such congresses, together with their relation to scientific and industrial activities, is a story of great interest. The electric literature of 1860 shows that telegraphy was then the only industrial application of electricity outside of electroplating. As a branch of physics, however, the theory of electricity was well developed, and nearly all of the fundamental laws were well known, as, for example, Ohm's law, the laws of electromagnetic induction and the laws of electrostatic induction. The practical application of those laws was, however, in a most backward condition. There were galvanometers, batteries and resistance coils, but their calibration was very crude.

The British Association for the Advancement of Science, appointed a committee in 1861, on Lord Kelvin's motion, to report upon the best unit of electric resistance. This committee of a few eminent physicists formed the first electrical congress.

In the following year the committee reported to the Association in favor of Weber's absolute metric system of electromagnetic units. An attempt was made to base the system on the British foot and grain, but fortunately the centimeter and gramme prevailed. Since 1862 all electrical units have been metric units.

The British Association continued its work for several years and the results were finally published in 1875. The committee not only established the C.G.S. system, but also created its half-brother, the practical system, of the quadrant and eleventhet-gramme variety. It determined the value of resistance coils in ohms and of current strengths in amperes. Its ohm, called the B.A. ohm, was 1⅓ per cent. short of the correct resistance, as more recently determined and adopted. It issued copies of the B.A. ohm and B.A. microfarad. It did most valuable service and laid the basis of all subsequent international work.

In the meantime the electric telephone and the electric light came into existence. These new industries greatly extended the needs of electric units, and electric measuring apparatus of an industrial type.

France, since her first Paris Exposition of 1855, has given evidence, like the sun, of an eleven-year cycle of expositions. They have succeeded each other in 1867, 1878, 1889 and 1900. Whether there is any deep sociological connection between these recurrences, and the eleven-year periods of sunspot activities, we leave as a curiosity to the curious. But in 1881 Paris gave a special international electric exposition, as a *hors d'œuvre*. At this exposition an international electrical congress was first convoked. The congress adopted seven articles of faith. The C.G.S. system and its half-brother, the ohm-volt-ampere-coulomb and farad system were adopted. An international commission was charged with a redetermination of the ohm, for practical purposes.

The international commission was convoked in pursuance of this resolution in 1882, and again in 1884. At the latter conference the "legal" ohm was adopted and defined as the resistance of a column of mercury 106 cm. long and 1 sq. mm. in cross-section, at the temperature of melting ice. This legal ohm was about 1 per cent. larger than the B.A. ohm, and about one-quarter of 1 per cent. shorter than the present generally accepted value. The volt was defined in terms of the legal ohm and of the ampere.

The second international congress was held at the next Paris International Exposition of 1889. There were three sections, the first devoted to units, the second to industrial applications and the third to electric signaling, comprising telegraphy, telephony and signals. The first section adopted the joule, watt and bougie-decimale. The second section the quadrant and various definitions in alternating-current technology, namely, definitions of period, frequency, mean and effective current strengths, effective e.m.f. and apparent resistance. The third section considered no units.

The third International Electrical Congress was held in connection with the Chicago World's Fair of 1893. At this congress, for the first time, papers were read and discussed on various subjects in theoretical and applied electricity, apart from the work of the chamber of delegates appointed by the various governments to consider and vote upon units and other matters of international importance.

At this congress there were 144 enrolled members, about 125 of whom were Americans. Some 500 persons attended the opening

ceremonies. The proceedings of the congress were published by the American Institute of Electrical Engineers. The chamber of delegates adopted the international ohm of 106.3 cm. of mercury, as an amendment upon the legal ohm of 106 cm. in 1884, which was an amendment upon the B.A. ohm of 104.8 cm., in 1875. The various other international units were adopted to match the international ohm. The international volt was defined in terms of the ohm and ampere fundamentally, but also collaterally as a fraction of the e.m.f. of a standard Clark cell, the specifications for the preparation of which were left to a committee. The committee has not reported. The international ampere was defined in terms of the rate of deposition in a standard silver voltameter. A table of international notation was accepted and printed as an appendix.

Two unofficial international electrical congresses were held at Frankfort and Geneva, in 1891 and 1896, respectively. No official government delegates were appointed to either.

There were three sections in the Chicago congress, Section A for theory, Section B for intermediate subjects and Section C for practice. Thirty papers were presented and discussed. The proceedings of the congress form an octavo volume of 488 pages. No provisions were made in advance for the preservation of this literature and it would probably have been lost if the American Institute of Electrical Engineers had not assumed the task of rescuing it and financial risk of its publication.

The fourth International Electrical Congress was held in Paris in 1900. Like all its predecessors, it was held in connection with an international exhibition. The French Minister of Commerce authorized the movement, which was originated by the Société Internationale des Électriciens. The organization of the congress was first established eighteen months in advance of the sessions and circulars were addressed to very many persons interested in electricity, inviting their adhesion. The total number of congress members enrolled was about 933, of whom about half were French and only a very few were Americans. There were five sections, with several sub-sections, in addition to a chamber of government delegates. About 120 papers or communications were presented and discussed. The only work accomplished by the congress in regard to international units was the christening of the C.G.S. units of magnetic flux and flux density under the titles of "maxwell" and "gauss," respectively. The proceedings of the congress were published in two octavo volumes of 526 and 318 pages, respectively.

The forthcoming International Electrical Congress of September, 1904, at St. Louis, was originated by the St. Louis Exposition, at the suggestion of a number of members of the American Institute of Electrical Engineers. A committee of organization was formed about fourteen months in advance of the sessions. About 5,200 invitations to join the congress have already been issued to persons interested in electricity. Over 1,000 acceptances of membership have already been received and the number is steadily increasing. Invitations have also been extended by the State Department at Washington to the various foreign governments asking them to appoint official delegates, as in the case of the two last congresses, in Chicago and in Paris. Invitations have also been sent to a considerable number of well-known electrical workers all over the world, asking for special authoritative papers to be read before the congress. About 120 papers have already been promised, in response to these invitations. No papers are to be read except by invitation, and the maximum number to be read has been set at 150, so that instead of having to press for papers the difficulty will apparently be to prevent the generosity of authors from exceeding the number of papers set by publication limits.

A feature of the St. Louis Congress, which has never before appeared, will be the official participation of societies and institutions interested either in the science of electricity or in its applications. The American Institute of Electrical Engineers has already adopted a plan of co-operation by holding a convention at St. Louis contemporaneously with the congress, and holding joint meetings with various congress sections, of which there are eight in all. By this means the papers in the joint sessions read on behalf of the Institute are to be printed in the congress proceedings, as being presented by the Institute, while the transactions during such joint sessions will be placed at the disposition of the Institute for incorporation in its own proceedings. It is expected that similar co-operation may be looked for from various other American and foreign societies, the purpose of the committee of congress organization being to enlist the aid and sympathy of electrical workers all over the world, not merely as individuals, but also as societies, the societies lending their influence to promote the success of the congress, and freely receiving a part of the congress transactions, as officially their own, to incorporate, if desired.

There seems every reason to hope for the success of the fifth International Electrical Congress in connection with the St. Louis International Exposition. The number and character of the papers promised, the number of the congress members and the efforts which all connected with the movement are freely contributing towards the enterprise, augur well for the result. The success of such a movement redounds to the credit, not only of the country in which the Exposition and Congress are held, but also to the benefit of electrical science and electrical industry all the world over.

The first electrical congress was made up of a handful of leading scientists of one country. Gradually the movement spread and broadened until an International Electrical Congress came to include scientists from all civilized countries. Now an International Electrical Congress means a carefully prepared organization in advance, a large membership, including not merely electrical scientists, but also very many who may only be interested in some industrial application of electricity. It means, moreover, the collection of theoretical and practical ideas from many sources and different countries, all uniting in a common cause, the increase of knowledge in the science, and the increase in the extent and usefulness of the science's universal applications.

The Ward Leonard Single-Phase Locomotive.

BY G. T. HANCHETT.

THE development of heavy electric railroading has brought to commercial usefulness a number of devices which have heretofore been of academic interest only. The series alternating-current motor and the repulsion motor belong distinctly to this class,

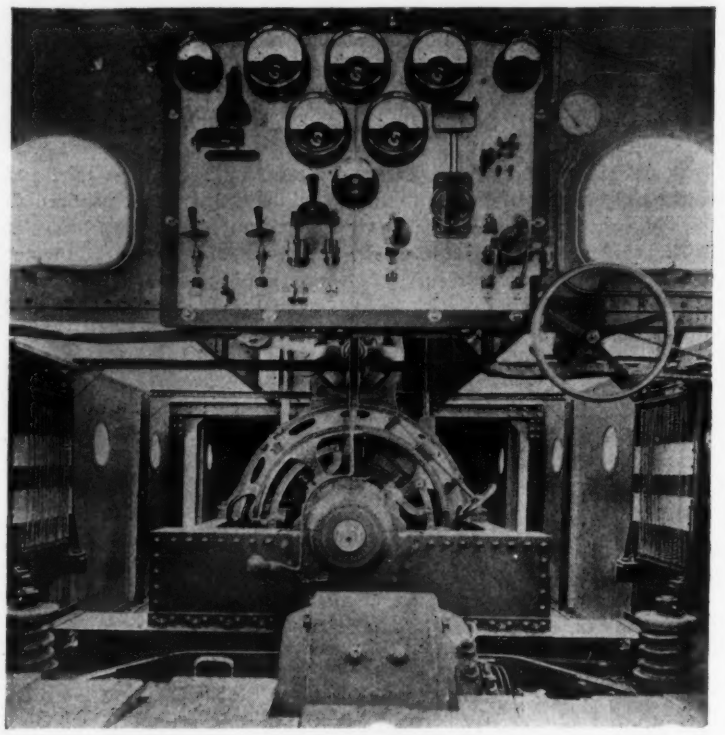


FIG. 1.—CONTROLLER CAB.

and it now seems that the Ward Leonard system of single-phase locomotion will develop into an apparatus of serious importance and consideration in large electric railway work.

To the superficial observer the Ward Leonard system seems to be a mass of unnecessary complication. It was brought before the public by Mr. Leonard in 1891, and briefly described, employs on the locomotive a synchronous or induction motor taking current from a single-phase system, and driving a direct-current dynamo which in turn drives direct-current traction motors suitably geared to the axle of the car. A superficial glance at the device does not impress the engineer favorably. He sees in such an apparatus a rotary system of energy transformation which is a bugbear that he

has studiously striven to avoid; and indeed when electric railroading was confined to the propulsion of 8 to 10 ton cars over the streets of our cities, that the time was not ripe for such a radical change for the application of electricity to traction.

It must now be remembered that the requirements of a traction system are now very much different from those that were all-sufficient some ten years ago. At that time the only consideration seemed to be a simple rugged reliable system which would make the wheels revolve. Now much more is needed, and it will be briefly rehearsed in the following paragraphs.

The modern system of electric traction requires: First—Reliability. Second—Economy. Third—A very specific and satisfactory curve of acceleration. Fourth—A system of control which is thoroughly reliable and free from detrimental effects of heavy arcs. Fifth—Simple adaptation to the multiple unit system of traction. Sixth—Ready adaptation to the use of electric power of any variety.

In the old days when it was customary to compare a simple pair of controllers and motors carrying moderately light currents, with the same equipment plus the additional apparatus required by this system, the situation was such that engineers were not inclined to be enthusiastic over the new plan, but now when we have to compare the Ward Leonard motor and dynamo with the complicated multiple troller and contactor contacts has in these days of great power become indeed a formidable difficulty, and this system, in which the only circuits which are manipulated are those of the field magnet carrying only a few amperes at moderate voltage, it is easily seen is free from this difficulty.

In the second place, the Ward Leonard system supplies its power to the motors without the interposition of rheostats, and it may be safely stated that the efficiency of such a system is undoubtedly superior to the system of rheostatic control even when reinforced by a series-parallel system. Therefore in point of economy of the car equipment itself, there are advantages in favor of the system, and furthermore it is capable of returning power to the line not at a critical speed but at any and all speeds, thereby providing an electric brake of most economical type. In all other traction systems, with the exception of a few which have not been particularly practicable, all the power employed in getting the current of the car under headway is subsequently wasted in heat at the brake shoes. In the Ward Leonard system, however, the accumulated energy of the car is transformed into electricity and fed back into the line, and moreover the system of braking is ideal. It is well known by traction engineers that the proper method of braking is to apply just sufficient braking power to prevent the wheels from skidding on the track.

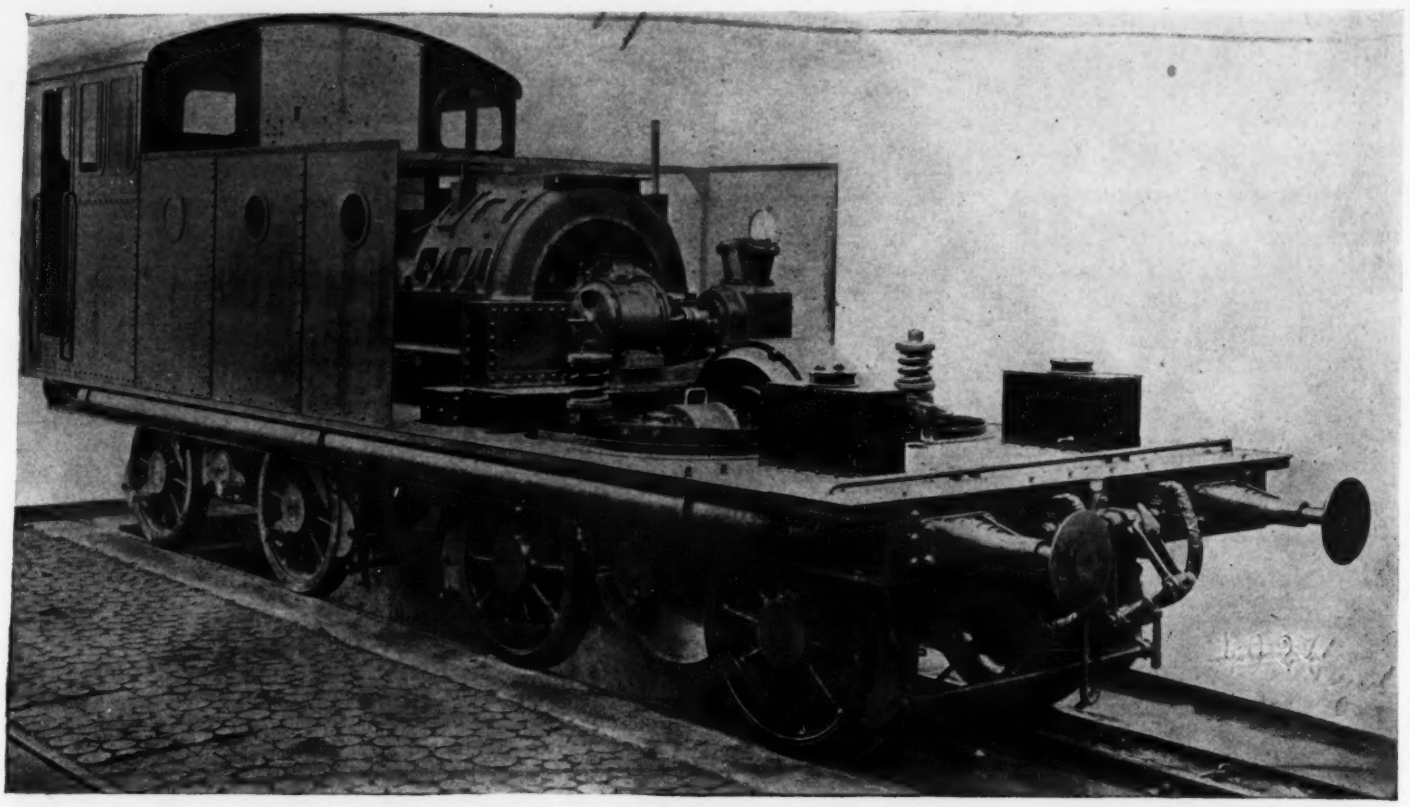


FIG. 2.—GENERAL VIEW OF LOCOMOTIVE.

unit arrangement, switching large currents, or with a system of transformers and voltage regulators, which are the modern alternatives, to obtain the results that can be obtained with the Ward Leonard system, the latter certainly merits some consideration.

This system as now employed at the Oerlikon Works in Switzerland, where it is undergoing a rigid test, consists of an induction motor adapted to receive and transform single-phase currents into mechanical power. This is transmitted to a dynamo of appropriate capacity by direct connection, and thence the current is distributed to the motors by means of the Ward Leonard control. To refresh the memory of those who are not familiar with this well-known system, it may be stated that in controlling a motor for variable speeds by the Ward Leonard system, the motor is given constant field and the voltage is varied by varying the field on the generating dynamo from zero to a maximum, and also in a reverse direction. Therefore the motors are permanently connected to the dynamo terminals, and there is no opening of the main motor circuit. Those who have had to do with the opening and closing of heavy traction circuits will appreciate that in this way an enormous difficulty is practically eliminated. The burning and melting together of contacts which is the bane of the multiple unit system is entirely avoided. A system whereby power is returned to the line does this automatically, for the moment that the wheels cease to turn, braking effort ceases also, so that by the simple device of weakening the dynamo field on the Ward Leonard system to such a point that the back electromotive force exceeds that of the dynamo, a very effective brake is produced and the energy of acceleration is returned to the line.

It may further be noted to the advantage of this system that the acceleration curve is practically under absolute control. An ideal acceleration curve is that which applies power to the motors in just sufficient measure to prevent the wheels from skidding. With motors in series, this skidding of wheels is a very objectionable feature, for one motor having begun to skid, its wheels absorb practically all the power for that purpose, leaving the other almost if not quite at rest, the only alternative being to shut off the power until the wheels get a fresh grip. With the Leonard system, all the motors are in multiple, and this defect is abolished. In applying the power, it is only necessary to strengthen the fields of the dynamo almost up to the point of skidding. If any of the wheels should skid, it is only necessary to drop back a notch or two to reach the result desired.

A further feature of this system of control is the fact that the

power taken from the line is directly proportional to the power used at the car and is not proportional to the amperes that happen to be flowing at the time in the motor. The motors may be carrying their full current and exerting their maximum torque, and at the same time only a small amount of power is required from the line for this purpose. With the ordinary system it is impossible to give the motor full torque unless the full power of the motor is taken from the line, which is thereby divided into two portions, a small portion going to the motor and the balance being absorbed in C^2R losses in the rheostats. This greatly simplifies power house design and management by wiping out the element of large starting current and heavy sudden loads.

Not the least of the advantages of the system are the ease with which it can be converted to the multiple unit plan. No bus train wires are necessary; in fact, the number of train wires can be reduced to a minimum of three light wires which supply the fields of the various dynamos on the equipments, and carry a few amperes only. A single rheostat and exciter provide means for raising these wires to any potential desired. The fields of all the dynamos come up uniformly, and with them the voltage of the traction motors. Consequently their speeds increase uniformly.

We are now able to prepare two interesting columns showing the advantages and disadvantages of the Ward Leonard system versus the ordinary heavy system of multiple unit direct-current traction. In this table all of the particulars which are common to both systems are omitted and the auxiliary apparatus of each is listed:

WARD LEONARD SYSTEM.	ORDINARY MULTIPLE UNIT SYSTEM.
Dynamo, motor and exciter.	Not less than 13 and usually more than 20 automatic contacts.
A simple system of low voltage wiring.	A complicated system of series parallel wiring and auxiliary contractor wires.
Acceleration under absolute control.	An acceleration curve seriously limited by the inherent qualities of the apparatus.
Minimum current from the power house when maximum starting torque is required.	Maximum current from power house when maximum starting torque is required.
Rheostatic control involving a rheostat waste of only a few watts at very light current.	Rheostat control wasting very large quantities of power at heavy currents and high voltage.
Return of power to the line and automatic braking.	No return of power to the line under any circumstances and no automatic braking.
The employment of any kind of power desired by the proper design of the receiving motor.	Complete re-design of the entire equipment necessary to use any one kind of power.
Weight in excess of that of the traction motor 100 per cent.	Weight in excess of the traction motor 25 per cent.

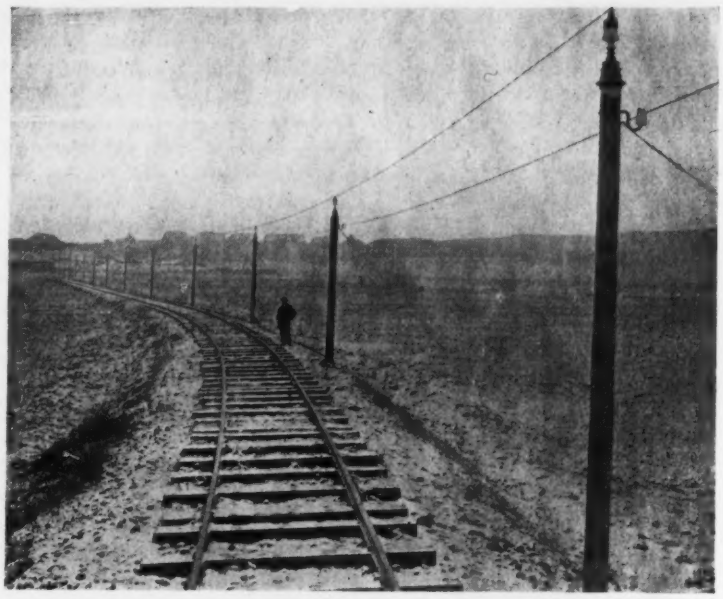


FIG. 4.—VIEW ALONG THE LINE.

A careful system of figuring, Mr. Leonard claims, will show that the added losses of the ordinary series-parallel rheostatic system of control will produce sufficient kilowatt-hours to more than carry the extra weight involved in his system, leaving a surplus for useful purposes.

FIG. 3.—THE MOTOR-GENERATOR.

These figures of comparison seem to justify the careful consideration of the traction engineer, and in fact that the system is now being tried in the Oerlikon Works in Switzerland seem to prove that this is being done.

In a paper read on the subject of electric traction on railways, before the Institute of Civil Engineers on February 18, 1902, Mr. W. M. Mordey, whose judgment on such matters is notably sound, made numerous statements which seem very pertinent in this connection. To quote them in toto is beyond the scope of this article, but a few selections may not be out of place. He says: "There need be no irregularities of control of speed, such as are caused by the notches in an ordinary series parallel controller. A perfectly smooth transition can be obtained through the whole

range, from large torque at starting and at low speeds, through all the variations of speed, to large power returned at stopping or braking. One further important point in this system is that it makes a much lower maximum demand than either the direct-current or composite system. It has already been pointed out that in the latter system (and the same is true of the three-phase system), the maximum demand occurs at the moment of starting, when the least power is being developed in the train. The output of the generating station and the losses in transmission, in transformation, and in wasteful resistance are then all greatest. Two-thirds of the power produced is lost in resistance. The one-phase system with its variable ratio gear saves all this, or a large part of it."

He further states that large starting torque of the single phase motors is not necessary in this system. Even if they should be so improved as to have a starting torque equal to that of direct current motors, it is likely that a variable ratio process would still be worth using, especially on lines with frequent stoppages. He closes by saying that sufficient has been said to show that the system possesses great flexibility, and offers at least a practicable solution of the problem of a comprehensive general system of electric traction for railways.

Mr. P. E. Huber, before the Zurich Association of Engineers and Architects, has set forth the advantages of the Ward Leonard system, and he gives some very interesting figures with reference to weights. He puts the weight of the locomotive at 44 tons, and states that a three-phase locomotive of equal power would weigh only about 30 tons. He holds that this advantage of weight is more than offset by the difficulties arising in connection with the trolley wires of a three-phase system. Mr. Huber's paper was read February 18, 1902,

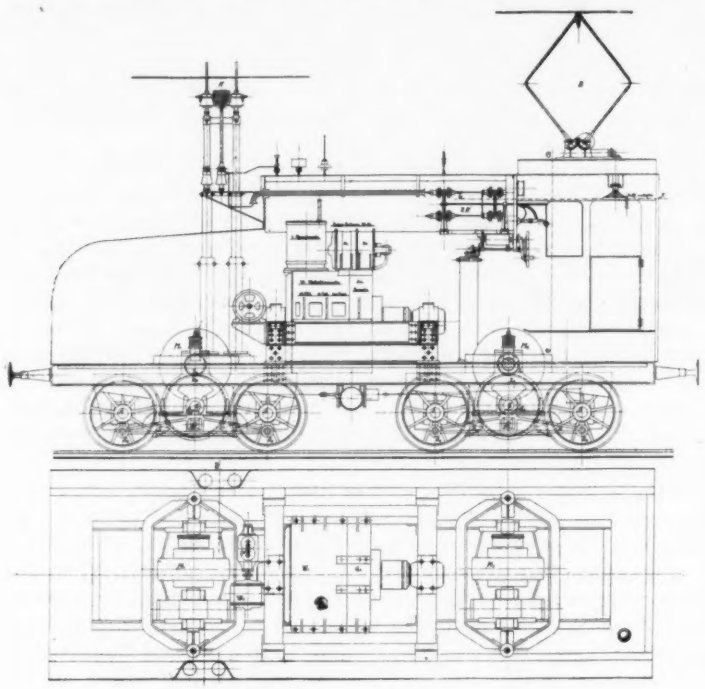


FIG. 5.—ELEVATION AND PLAN OF LOCOMOTIVE.

and at that time he did not have at his command data with reference to the additional weight and complication required by the multiple unit system, which would have naturally added further to his remarks in favor of the flexible controller offered. During the latter part of the year 1902 the Royal Commission of Swedish Engineers reported to the Crown upon the practicability of substituting electricity for steam power, and after carefully considering the various single-phase systems then extant, reported in detail upon the Ward Leonard system. This report was reported in the Swedish periodical, *Teknich Tidskrift*, of January 10, 17 and 24, 1903, and after making every proper allowance for the cost, operation and installation of the Ward Leonard system, a net yearly saving was estimated at $2,000,000. Details on the subject were given at the time in the pages of the ELECTRICAL WORLD AND ENGINEER.

In connection with the Oerlikon work the illustrations accompanying this article may be of some interest. In Fig. 2 is shown the locomotive arranged on the Ward Leonard system. It comprises in one frame a motor-generator. The traction motors are arranged so that they come one-half above the car floor, and are geared to an axle below which is connected to the wheel by means of connecting rods. The controller cab shown in Fig. 1 displays various instruments and circuit breakers essential to the operation of the system and the rheostatic control is shown at the left. Fig. 3 exhibits in more detail the motor-generator, which, it will be seen, is a very compact and convenient machine.

Fig. 4 shows a section of the roadway, which is interesting because of its peculiar method of top contact, for the trolley wheel, the trolley resting on the top instead of on the bottom of the wire, as is common in American practice. Lastly, Fig. 5 displays to good advantage a diagram of the Ward Leonard locomotive, in which is shown the motor-generator exciter and its transformer, the main motor-generator, the traction motor and connecting rods, in which it is interesting to note the flexible sliding link connecting the motive shaft of the connecting rod.

It is to be hoped that the work of such a well-known American inventor may not be compelled to look exclusively abroad for its exploitation. Such experiments should be undertaken in America, and the present state of the art is such that careful work is certainly justified.

Institute Meeting on Air and Circuits Under High Voltages.

The 184th meeting of the American Institute of Electrical Engineers was held on February 26 at the Chemists' Club, New York City. The meeting was called to order by Vice-President Lieb and the secretary announced that at the meeting of the board of directors, held in the afternoon, 67 associates had been elected.

A very elaborate paper on "The Conductivity of the Atmosphere at High Voltages" was presented by Prof. Harris J. Ryan, of Cornell University. He first analyzed the results obtained several years ago by C. F. Scott in the laboratory in Pittsburg and afterwards by R. D. Mershon on the Telluride line in Colorado. Prof. Ryan deduced from theoretical considerations a formula which he had found to represent correctly Mershon's results, but not those of Scott, nor those of other tests in which he had himself repeated Mershon's tests in the laboratory. He then traced the disagreement to the fact that in his first formula he had neglected the influence of the temperature and pressure. He, therefore, studied this problem and arrived at the following final equation:

$$Emax = \frac{17.94\,b}{459 + t} \times 2{,}055\ log_{10}\left(\frac{s}{r}\right) D'\,(r + d) \times 10^{10}.$$

In this equation $Emax$ is the maximum value of the voltage wave, applied to the line, b is the barometric pressure in inches of mercury, t is the temperature in degrees Fahrenheit, s is the distance of the line conductors from center to center in inches, r the radius of the line conductor in inches, d the distance from the conductor surface at which the strain due to the electrostatic field causes initial atmosphere rupture, and D' the strength of the electrostatic field of force (dielectric flux density) that will electrically rupture the atmosphere at the distance d from the surface of the conductor with radius r, D' being measured in coulombs per square inch.

For diameters of conductors larger than 0.250 inch, the values of d and D' are constant and the above equation assumes the simpler form,

$$Emax = \frac{17.94\,b}{459 + t} \times 350{,}000\ log_{10}\left(\frac{s}{r}\right) (r + .07)$$

The author had made efforts to determine the effects of the presence of moisture upon the point at which the atmosphere about high-voltage lines becomes conductive, i. e., upon the point at which the sudden rise in the loss curve occurs. However, no definite effect of this sort could be found, and this is practically in accord with Mershon's conclusions after his observations made upon the Telluride line under variable weather conditions.

From the above equations the following table was calculated by the author. It shows the corresponding diameters of line conductors that must be employed to avoid loss between wires for a series of line voltages wherein the barometric pressure is 29.5 in. of mercury, the temperature 70° F., and the distance between the conductors 48 in.

Maximum volts at which atmospheric conduction loss occurs.	Corresponding effective volts (sine wave).	Operating pressure 90 per cent. of corresponding effective volts.	Diameters of conductors in inches.
78,500	55,000	50,000	0.058
118,000	83,300	75,000	0.106
157,000	111,100	100,000	0.192
235,500	166,600	150,000	0.430
314,000	222,200	200,000	0.710
392,000	277,700	250,000	0.990

Prof. Ryan pointed out that the real voltage limit to-day in transmission is due to the insulator, where the line has to be exposed to the weather. In future the insulator difficulty will be solved in one way or another and higher voltages will be used. Possibly in large undertakings the line may be protected from the elements by means of a continuous covering. When such high voltages are employed atmospheric conduction, or "the brush," or, as Steinmetz calls it, the "corona" must be avoided. Prof. Ryan found that the brush discharge or corona occurs always when a definite strain exists in the atmosphere next to the high-voltage conductors, and that to avoid such corona with its destructiveness and waste of power, it is necessary on transmission lines and auxiliaries to proportion things so as to keep the dielectric strain of the atmosphere below a definite point, above which the corona will inevitably appear.

In the above table a factor of safety of 1.11, or a margin of 10 per cent. was allowed by Prof. Ryan in estimating the safe voltage at which to operate so as to avoid losses due to brush discharge; but this was a laboratory conclusion only.

Concerning the maximum of the voltage wave, Prof. Ryan pointed out that almost invariably the line charging current will cause an important line voltage wave—distortion—so that the maximum of the wave (upon which the corona formation primarily depends) will exceed the effective value of the voltage by a factor much greater than the square root of two. He also pointed out that the insulators must also be properly proportioned, otherwise the presence of the insulators made of material that has a considerably greater permeability to dielectric flux than the atmosphere, will cause corona to a greater or less degree to form over the conductors in their neighborhood. This will likely be accompanied by corona over the pins inside the insulators, resulting in their ultimate injury if made of wood, from this cause alone, even if the surface leakage current is so limited as not to injure the pin.

Prof. Ryan closed his paper with the suggestion that when viewed in the dark the corona, formed upon wires of given diameters and distances apart, provides a method for gauging high voltages that is free from the short-circuit and surging disturbances occasioned by the use of the spark discharge method. Either two parallel conductors or a conductor mounted at the center of a cylinder may be employed for this purpose.

The discussion was opened by Mr. C. F. Scott, who characterized Prof. Ryan's paper as a remarkable one, reaching out into the future and the unknown. It dealt with something beyond the present commercial practice, but something toward which the actual engineering work of the present time is fast approaching. Mr. Scott then spoke of his own experiments made in the laboratory in Pittsburg, and of those made by Mershon on the Telluride line, and presented a communication by Mr. S. M. Kintner, who pointed out that on account of the influence of temperature, if a range from 25° below zero in winter and 125° above in summer is taken, there would be a range of 30 per cent. in the voltage at which the corona would appear. With respect to the effect of the use of small or large wires upon the discharge, Mr. Kintner pointed out that this would indicate that blunt gaps are more reliable for measuring voltage than needle points.

Mr. Scott also read a communication from Mr. P. M. Lincoln, who first raised the question whether any loss in our present transmission lines is due to the corona effect. From Prof. Ryan's paper it follows that this is not the case. For the very worst conditions which would occur in actual practice, viz.: a No. 6 wire with a spacing of say 48 in., the corona loss at sea level does not begin until the voltage has reached the neighborhood of 100,000 effective. For the maximum altitude at which transmission is apt to be carried on, say 10,000 ft. above the sea level, the voltage at which the loss begins may be as low as 65,000 for the worst cases, but still considerably beyond the limits of the actual practice of to-day. Normal progress is bound to carry transmission voltages beyond those used to-day, hence it is important to consider which remedies are available to counteract the losses. It is well known that a good rubber insulation on the wire will almost entirely prevent the corona loss, at least within the lower limits of voltage at which the effect occurs. Mr. Lincoln pointed out that it would be interesting to determine the effect of various kinds of insulation on the loss.

Dr. S. Sheldon then spoke on the character of the various forms of discharges through air, as distinguished by the names glow discharge, brush discharge, spark and arc. The glow and brush discharges are probably due to a sort of gaseous ionization, and Dr. Sheldon is of the opinion that this corona discharge is a combination of both these discharges.

Prof. H. B. Smith spoke of an electrometer which he had devised for high potential measurement, and Mr. P. H. Thomas asked various questions which were answered by Prof. Ryan. It was pointed out that it would be interesting to compare the effect of substituting aluminum for copper wires upon the loss. Mr. Thomas stated that he had made direct measurements of the loss from the line into the air on a 50,000-volt plant, with a length of something less than 100 miles. The loss began to be measurable at about 20,000 or 25,000 volts and ran then up very steeply. At 60,000 volts the loss amounted to a total of 10 kw, which is insignificant for power transmission purposes, but yet a measurable loss.

A paper on "European Practice in the Construction and Operation of High-Pressure Transmission Lines and Insulators," by Mr. Guido Semenza, was then presented. In the absence of the author it was read by Mr. J. W. Lieb. The author pointed out that a transmission line needs just as much careful design as any electrical apparatus and first refers to the calculation of the best wire section; this problem is best solved by a graphical method. The next question is the route of the line. He then discussed at some length the comparative advantages of wooden and iron poles. The advantages of iron poles are, durability, the possibility of using large spans and lower cost of maintenance. Their disadvantages are a somewhat greater capital investment and the necessity of using better insulators. He thinks that the adoption of iron poles for important transmission lines will become more and more general.

The author gave an outline of the best way of proceeding in the design of a line, and discussed at length the design of insulators. Wooden cross arms are sometimes employed with iron poles; but, in general, supports constructed entirely of iron are preferable. A special cement is employed to fasten the insulators to these brackets, or, in the case of small lines, tarred rope is employed. This differs entirely from American practice, and no attempt is ever made in Italy to use threaded insulators, as it is difficult to obtain good insulators with thread of the exact gauge. The best cement for this purpose consists of 10 parts of litharge and 1 part of glycerine, well mixed. The brackets and insulators thus cemented together form an indivisible unit.

When the span exceeds a certain length, care must be taken that the wires do not come in contact through their oscillation due to the wind. It is obvious that in order to avoid such a contingency it is necessary that two or more wires should never be placed on the same level, and the adoption of cross arms as practised in America should not be followed, in the opinion of the author. In any case, it is easy to calculate the deflection of the wires from their vertical position, due to the force of the strongest wind prevailing in the country and midway of the span, thus finding the distance between the insulators to prevent the wires coming in contact.

The problem of high-pressure insulation is very carefully studied by European electricians. Glass insulators are not used in Europe probably because good porcelain can readily be obtained there. Glass is considered to have a better dielectric strength, but not as good surface insulation; moreover, glass is weaker against meteorological agencies, the superiority of porcelain being due to the materials composing the glazing. European engineers do not consider American porcelain as good as European porcelain. It is possible that they may be mistaken, but a few tests made by the author on American insulators showed a higher dielectric resistance for the European porcelain, which in appearance, finish and homogeneity of material is much better.

In designing an insulator the following points are to be considered: Dielectric resistance, resistance against surface arcing, mechanical strength, facility of cleaning, ease of construction.

The first two points have reference to electric qualities and an ideal insulator ought to be so proportioned that, under a certain voltage, it should break in both ways, by puncture and by surface arcing. The resistance against puncture can be increased by making

the insulators of several pieces, introduced one piece inside the other. In general, the different pieces are cemented together with a kind of glazing in the process of manufacture and put on the market as single pieces.

The author does not follow this practice, but prefers having them furnished by the factory in separate pieces, for the following reason: When the thickness of the pocelain reaches a certain limit the ordinary testing will not puncture a sound insulator. In testing an insulator made up of two or more pieces, one layer of porcelain may be cracked, but is protected by the other layers. When the tests are performed on the single component parts, this cannot happen, and one is sure to have the insulators made up of sound parts. Moreover, each composing part can be better inspected and the character of glazing observed. Following this suggestion many factories produce insulators in two parts, which, after test, are put together with glycerine and litharge cement. Experience has demonstrated that it is useless to increase the number of component parts; up to 40,000 volts two parts are quite sufficient and above that voltage not more than three are necessary.

The ability of an insulator to resist surface arcing is due to its dimensions and shape, the latter to be considered under a double aspect, the protective action against moisture and rain; and the property of giving origin to electrostatic phenomena. An insulator with a very large petticoat on the top and only a second petticoat round the pin will not afford a very good protection against rain and moisture, as during a storm the inner petticoat will get quite wet. It is, therefore, good practice to have one or two intermediate petticoats, which will also insure the dryness of some part of the surface in all kinds of weather. Care must, however, be taken not to put on too many of them, as their edges would come too near, thus forming a good path for the arc, besides increasing the difficulty of cleaning the insulator. The use of intermediate petticoats should be limited to those strictly necessary to protect the inner part from rain and to insure that a part of the surface shall be quite dry.

The discussion was opened by Mr. Lieb, who said that the paper indicated the character of analysis which European engineers give to mechanical problems when they are presented. While perhaps European engineers may not be as active in undertaking pioneer work in new fields, particularly where much investment and commercial development are necessary, yet when these applications are once made by them the constructions are subjected to very careful analytical treatment. Mr. W. N. Smith remarked that the method of construction of the high-tension lines described in the paper is quite different from our usual practice and might perhaps lead to complications in this country, for instance, from the small boy nuisance.

President Arnold remarked that just such a line, as described in the paper, has almost been completed in Mexico. It is about 100 miles long, built with steel towers, regular wind mill towers, using seven poles to the mile and supposed to be the most modern line now built. When the New York Central Railroad recently considered the transmission question, the conclusion was reached that it is safer and more reliable in operation to have the transmission wires overhead on steel poles than to put them in conduits.

Mr. L. L. Perry remarked that some constructions shown in the paper might be due to local European conditions, for instance, narrow streets. Mr. W. E. Dix said that he thought that American insulator manufacturers are now adopting the suggestions of the writer of the paper, viz.: to reduce the number of petticoats, increasing the surface and also increasing the space between the petticoats, thus reducing arcing and leaking. Mr. C. F. Scott agreed with the author that there is a difference between the engineering inside the station and that outside the station. In many cases the external line construction lacks the standardization, the uniformity, and the higher grade of considerations which have generally been given to other departments of manufacture.

Big Searchlight for the World's Fair.

The General Electric Company is building the largest searchlight made. It is to take 300 amp. and the lens is 7 ft. in diameter. This will be used by the Clark Publishing Company, of St. Louis, on top of its tower which is being built adjoining the World's Fair grounds. It is not unlikely that experiments with telephony over this searchlight beam will be made during the progress of the Fair.

Early Days of the Brush Arc Light.

BY S. M. HAMILL.

The wonderful story of the past twenty-five years of the development of the electric business is ever new to all of us. The able men of the electrical journals who from week to week have chronicled this story, educators in the business, constantly stirring up the new and raking over the old, have exerted a powerful influence for which the world owes them a debt of gratitude.

The Brush Electric Company was the first in the field in the era you celebrate this week. Stockly, its president, and his assistants, Tracy, Swift and Potter, were men of energy and ability. From 1879 to 1884 they accomplished a great work. The Brush system of arc lighting was soon perfected and it was pushed for all there was in it. The first series street arc lights were erected in the Public Square in Cleveland, Ohio, in 1879. Shortly thereafter local electric light companies were started in all the large cities and towns in the country. Millions of dollars were raised for the purpose. Leading men of the country were induced to invest their money and to take part in the management of the enterprises. Europe and Asia did not escape. Even to-day, in England, the Brush influences persist. Potter in the early eighties organized local companies in Japan and China. Brush with his genius for designing and constructing a new system that worked well. Stockly with his few energetic able assistants, accomplished results seldom equalled in the history of any new industry.

They were pioneers of the highest order: First, in the electric lighting field; second, in getting rich quickly in the electric business; third, in selling their company to a modern combination.

We may not yet be far enough away from Brush's early work in the development of electrical apparatus and his electric lighting system in order to appreciate fully what he accomplished. Time will place him on a lofty pedestal. So far as his actual accomplishments were concerned, during the early days prior to 1884 he was easily the leader. Between the years 1878 and 1884 he rose rapidly to prominence, and his name and reputation were world-wide. Distinguished honors abroad were conferred upon him. The apparatus which he designed and the building of which he superintended was widely used, and brought him and his immediate associates large fortunes.

Brush was a university-bred man, having graduated from the University of Michigan in 1869 with the degree of Mechanical Engineer. This was rare and was before the days of electrical engineering schools and accounts in part for the mechanical perfection of his apparatus.

While the factory of the Brush Company in the early days of its history was small in comparison with the great factories of to-day, yet for its time it was enormous, and turned out millions of dollars worth of apparatus which was shipped to all parts of the globe. Many of the engineers, or what were so commonly called "inventors" in the early days of electric lighting were not particularly good business men. The fact that few, if any of them, have amassed any wealth indicates this. Brush had very keen business instincts and not only was fortunate in his business arrangements with his company, but was a wise and conservative adviser. He loved work, which was always done thoroughly and remarkably well. The Brush dynamo so largely used to-day is to all intents and purposes the same as that designed and built by Brush in 1878. The arc lamp, with his magnetic cut-out for series circuits, the storage battery and the arc light carbon, each the foundation of a great industry, have not drifted very far from his original ideas and inventions.

In 1879 Brush was poor; in 1886 he was very rich, with a beautiful home and large grounds in Cleveland, O., where he lives to-day, devoting his time to scientific work in his laboratory and in caring for his large interests. Take it all in all, no one man has contributed more than Brush to make this electrical age what it is; and to the writer, intimate association with such a leader has not been the least pleasure of a laborious electrical career.

Wireless Telegraphy for Russia.

A dispatch from Paris says: "In order to prevent interruption of the telegraphic service during field operations in the Far East, a French company of wireless telegraphy is arranging to provide the Russian Government with a wireless system which will enable it to communicate between stations thirty miles apart."

Great Northern and City Railway, London, England.

The latest London electric railway opened to traffic is a line which joins the Great Northern Railroad station at Finsbury Park, just at the four-mile radius, with the heart of the city in an almost straight line. It is 3½ miles long and furnishes the shortest and most direct underground route from this station to London's business section. The new line runs through a very densely populated district of workers, who, up to the present time, depended for entrance to the city on omnibuses and tramways, both of which take considerably more than double the time to reach the city than is required by the tube trains. This economy in time is expected to attract a great deal of traffic. It is estimated that at least 5,000,000 passengers per mile, or a total of 17,000,000 passengers per annum, may be looked for from local business alone. These figures are considered very conservative, as the Central London Railway, for instance, is carrying about 7,000,000 passengers per mile per annum. About 30,000,000 passengers per annum are brought to Finsbury Park, via the suburban trains of the Great Northern Railway. It is figured that at least one-third of these passengers will use the new direct line in preference to the roundabout older ones, thus adding 10,000,000 passengers per annum, making an annual total of 27,000,000 passengers.

The underground portion of the line consists of two 16-ft. diameter tunnels, opening out to nearly 23 ft. diameter at the stations. As

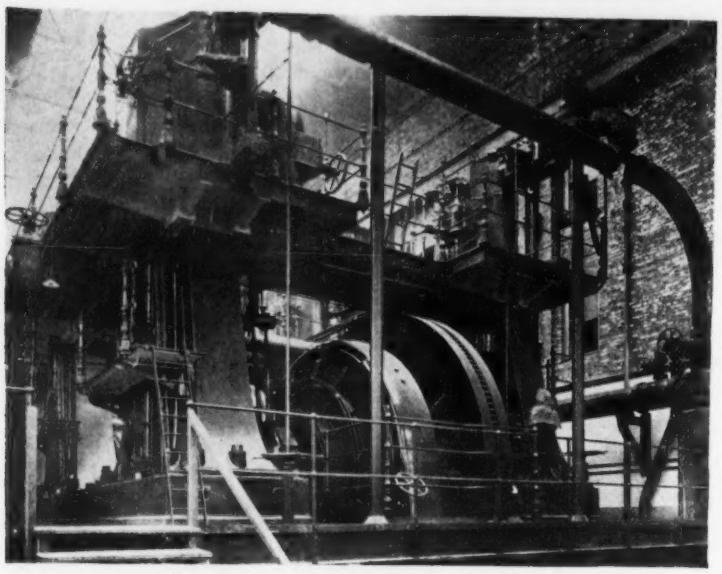


FIG. I.—ONE OF THE UNITS.

the diameter of the Central London Railway tubes is 11 ft. 8 ins., and the City & South London Railway only 10 ft. 6 in., the new line is able to carry larger rolling stock and enjoy much better ventilation than the others. The track and tunnels are also arranged to permit the standard cars of the Great Northern Railway to run through the Great Northern & City Railway's tubes should it be found desirable to make the necessary connections.

A novelty in connection with the construction of the tunnels is the introduction, for a very great proportion of their length, of a vitrified blue brick invert. It has been demonstrated by trial runs that this material combined with a cast-iron roof will minimize noise and vibration. It is less resonant than complete iron rings, and the fact that the tubes are constructed of such different materials makes the transmission of sound waves more difficult with a consequent noise reduction.

The standard trains are made up of seven cars, three motor and four trailers, having a total approximate seating capacity of 430. The first motor car is at the front of the train, the second in the center, and the third at the end. The approximate weight of the loaded train is 200 tons.

The cars were built by the Electric Railway & Tramway Carriage Works and the Brush Electrical Engineering Company. They are supplied with Westinghouse quick-acting brakes. Each motor car carries a British Thomson-Houston motor-driven air compressor, reservoir, etc. There are also conductors' emergency cocks at the end of each car for applying the brakes in case of need.

Each motor car is carried on two McGuire trucks, having 36-in. diameter driving wheels. The trailer cars are mounted on Brush trucks. On each truck of the motor cars is mounted one 550-volt, series wound, direct-current motor. Current is collected by four collector shoes per truck.

The capacity of each motor is 125 hp, rated on the basis of 75° C. rise in temperature above the surrounding air after one hour's run on full rated load. The gear is of steel, machine cut, and enclosed in a waterproof case. The motors are controlled by the General Electric multiple-unit system. An interesting fact in connection with this installation is that the Great Northern & City Railroad was the first British electric railway to adopt the multiple-unit control system.

A 3-minute service will be introduced, single trips being completed in 13½ minutes, which permits four intermediate of 20 seconds each. The trains will be shuttled at the termini thus avoiding shunting around the stations. It is hoped to be able to maintain a 3-minute service throughout the day simply by shortening the trains, so that they may be run profitably on each short headway.

The power for operating the system is supplied from a single generating station located at Poole Street, New North Road, about a mile north of Moorgate Street station. The length (3½ miles) of the line and position of the generating system are such as to enable the system to be operated without feeding in at several points, the current being transmitted directly to the collector rails. The generating machinery also furnishes the current for lighting and the operation of the passenger elevators.

The site adjoins the Regent's Canal, from which water is being taken for condensing and other purposes, and returned to the canal at a point 300 ft. on the down-lock side of the in-take. Its connection with the Regent's Canal also permits fuel to be delivered cheaply alongside, from whence it is conveyed to the storage bins and fires by a Hunt gravity bucket conveyor, which handles 30 tons of coal an hour.

Steam is supplied by ten boilers, each having an effective grate area of 40 square feet and capable of evaporating 11,200 pounds of water per hour at 212° F. when using coal giving 13,500 B.T.U. The boilers are fitted with automatic stokers, driven by two motors.

The four main engines are of the vertical cross-compound type, built by John Musgrave & Sons, Bolton. The engines give 1,250 hp at 100 r.p.m. and 150 pounds pressure. They have fly-wheels weighing about 45 tons each, and are capable of sustaining 100 per cent. overload momentarily. They are direct-connected to four railway-type generators, rated at 800 kw each, but capable of taking for two hours, without objectionable heating, a load up to 1,200 kw. These generators are also able to carry momentary overloads of 100 per cent. without injurious sparking. They are British Thomson-Houston compound-wound to give 525 volts at no load and 575 volts at full load.

Two engines of the single-acting, tandem-compound type, built by Davey, Paxman & Co., drive two B. T. H. six-pole 120-kw generators at 375 r.p.m. They are compound-wound for the same voltage as the main generators, and have an overload capacity of 50 per cent. for two hours. They will supply power for lighting of power house, etc., and for operating the electrically-driven auxiliary plant when it is not convenient to take power from the main generators for this purpose.

There are four Wheeler surface condensers, each having a cooling surface of 2,400 sq. ft., and arranged with steam-driven combined air and circulating pumps. They are capable of maintaining a 26-in. vacuum when dealing with 2,200 pounds of steam per hour. There is also an auxiliary condenser of the same type, capable of handling the auxiliary plant and boiler feed pumps' exhaust. These condensers discharge into a hot well, from which the water is delivered by two three-throw vertical lift pumps of the Blake-Knowles type, driven by enclosed motors. All the condensers have combined air and circulating pumps, driven by steam. In addition to the supply from the canal mentioned previously, water can be obtained from the city mains. A storage tank has been provided connected directly to the latter.

The water taken from the canal is dirty, and varies in hardness from time to time during the year by reason of floods and droughts. For softening and purifying both this and the town water, which is also variable, a Desrumaux plant has been installed in the rear of the boiler house, capable of treating 8,500 gallons per hour. This gives water having its hardness reduced to 5° and alkalinity to about 6°, free from solids. An automatic arrangement is adjusted between the

softener and storage tank, whereby the softening process is suspended and recommenced as occasion may require, thus giving a continuous supply of purified and softened water, with a minimum of supervision. A Masson-Scott plan is installed for removal of oil and grease from the water of condensation and for the purification of the water for boiler feed purposes. This plant is capable of dealing with 10,000 gallons per hour.

The oil and grease which has passed through the steam engines is in the form of a divided emulsion, so fine in its character that it is impossible to remove it by mechanical filtration alone, chemical treatment as well as filtration being essential. The apparatus is thus a combined plant for first chemically treating, and finally filtering every gallon of water which leaves the surface condensers, producing a perfectly clear effluent, free from grease of chemical admixtures and of a fixed degree of hardness suitable for boiler feed purposes.

A switchboard, consisting of four main-generator, four-feeder, two auxiliary generator panels, three-auxiliary power and three-auxiliary light panels, is installed in a gallery at one end of the engine room, commanding a view of all the main generators. The circuit breakers are of the magnetic blow-out type, and the measuring instruments of the astatic illuminated dial and feeder type.

Cables run from the switchboard along the outside of the boiler house wall and then down a special cable shaft into the tunnels. The bus-bars on the board are so divided that the auxiliary-generator lighting and auxiliary-motor panels can be isolated from the main generator and heavy feeder panels by the operation of one switch, insuring the uninterrupted operation of the lighting system if any accident occurs to the main power circuits. Separate paper-insulated feeding cables are provided for traction, for lighting and for elevators, and rubber insulated cables for lamp circuits and connections.

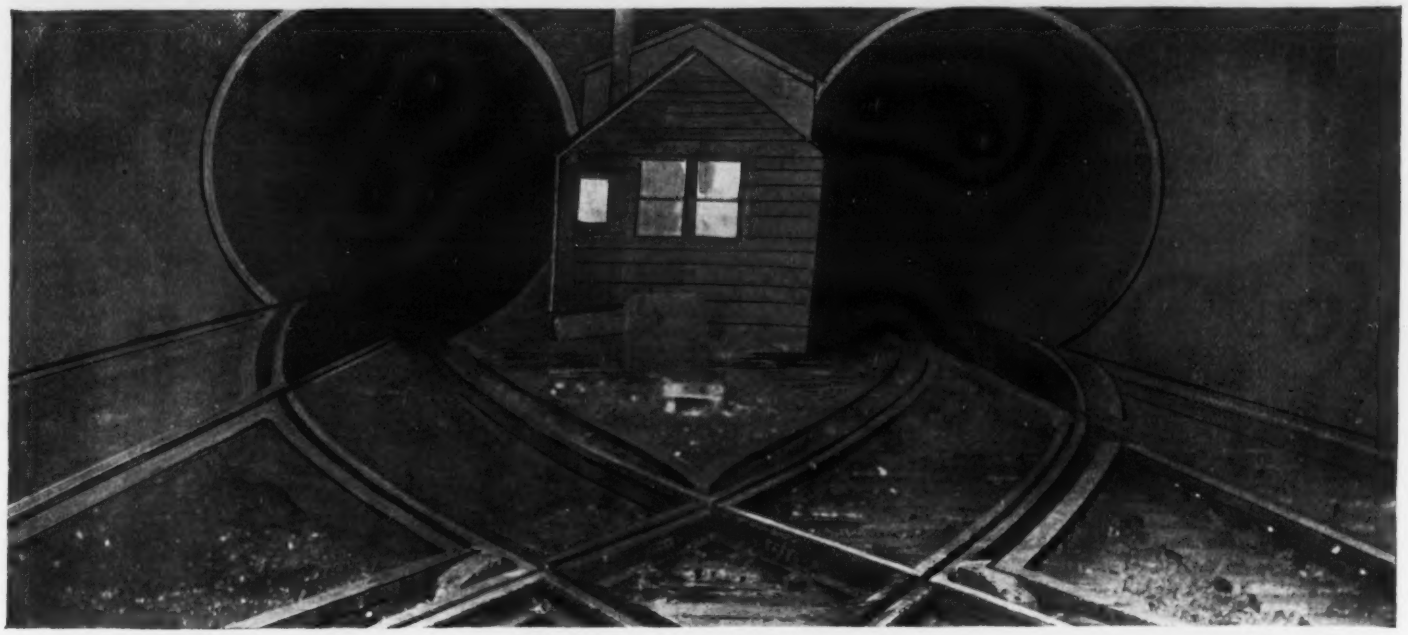


FIG. 2.—ENTRANCE TO THE TUNNELS.

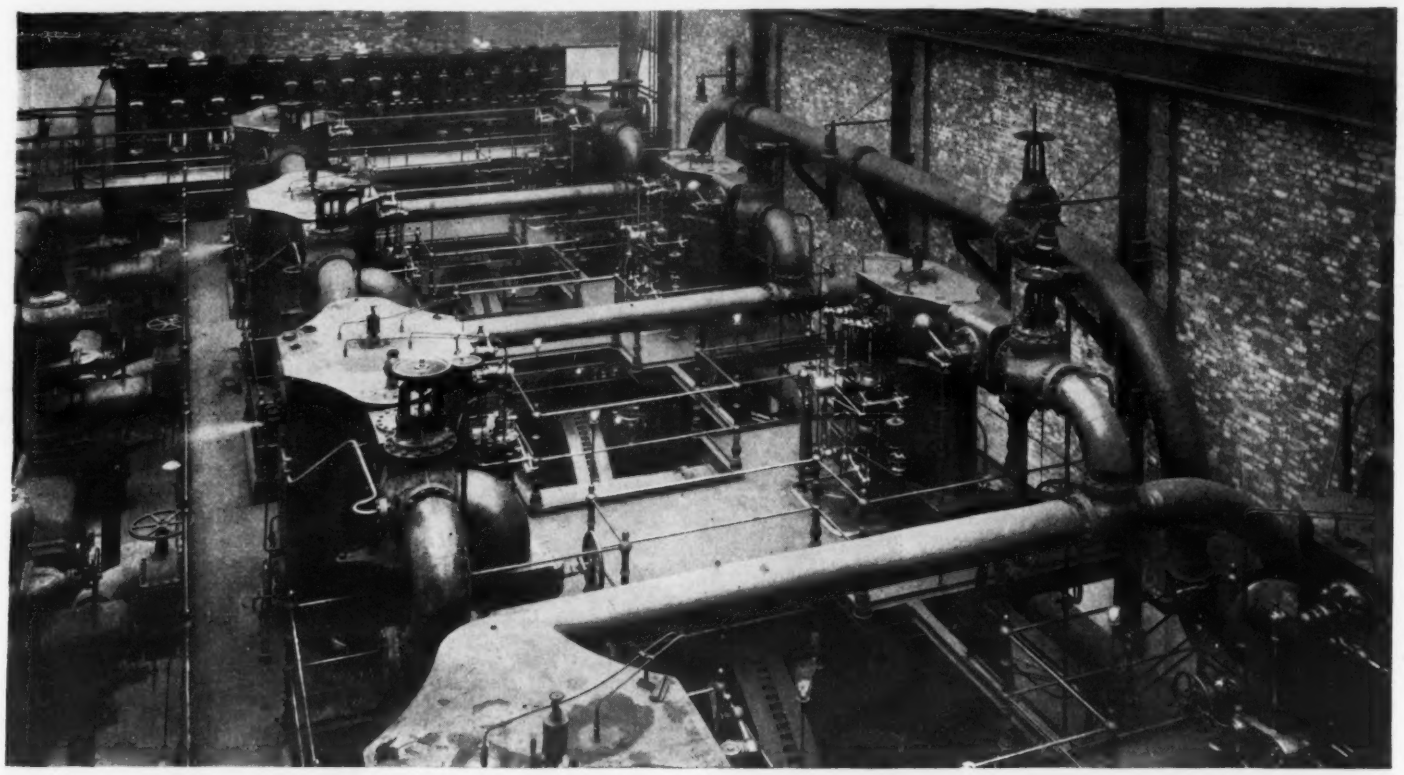


FIG. 3.—GENERAL VIEW OF POWER STATION.

The other station plant comprises steam-driven feed pumps, motor-driven economizer, two motor-driven lift pumps, storage and receiving tanks, water softening plant, one 30-ton three-motor overhead crane, etc.

Two insulated conducting rails are used per track, one being for the return circuit. Both rails are placed outside of the running rails. The conducting rails are of channel section, weight 80 pounds per yard, and are rolled to about 42-ft. lengths. They are of a special

quality of low-carbon steel, having a conductivity of 14 per cent. of that of pure copper of equal area. These rails are supported on earthenware insulators, 10 in. outside of the gage, carried on spindles supported by cast-iron brackets fixed to the sleepers. The system of collector rails is divided up into four sections, fed independently from the generating station. The running track is laid to standard gage, consisting of 85-pound flanged rails laid on longitudinal stringers in the tunnels and on cross-ties in the open. As it carries no current it is not bonded.

All lighting circuits are carried in iron tubes, and the tunnels are

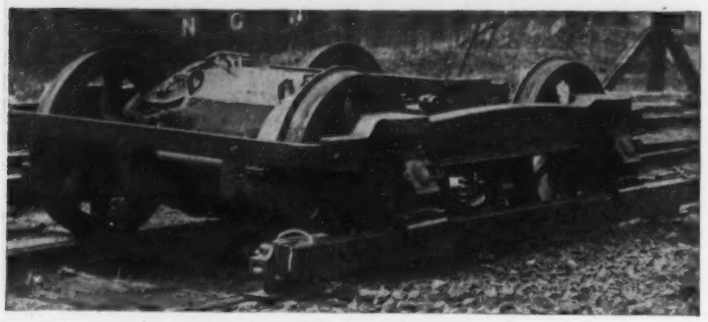


FIG. 4.—VIEW OF ONE OF THE TRUCKS.

provided with lamps every 100 ft. The passenger stations are lighted on the rail and street level by enclosed arc lamps, and station switches are fixed which control the incandescent lamps in the tunnel halfway to the next station in each direction. The lamps are placed five in series, and the circuits are run so that there is never more than the voltage of one lamp between two adjacent wires in the same pipe. Special throw-over switches are provided to take the lighting current from the conductor rails when the special lighting cables are not charged.

Power Transmission in Washington State.

Mr. Herbert Hunt, of Everett, Wash., furnishes some interesting details as to the May Creek power plant of the Everett Railway & Electric Company, on Lake Isabel, 32 miles east of that city. The plant is designed to furnish 15,000 hp to Everett for the street railway, public lighting and private power, as well as for the Everett-Snohomish interurban line of 12 miles, and later to supply other interurban trolley lines which this company will build.

The intake for the 32-in. steel pipe will be 30 ft. below the surface of Lake Isabel. The pipe will be carried 12,000 ft., with a fall in that distance of 2,500 ft. This distance will be shortened by 4,000 ft. if the company determines to tunnel a granite hill lying between the lake and site for the power house. Owing to the pressure special steel pipe has been ordered. Toward the nozzle the pipe decreases in diameter to 20 in.

The diameter of the nozzle itself will be but 5/8 of an inch. A wheel of the Pelton type will be used. One 5/8-in. stream will develop 10,000 hp. Later, when additional power is needed, another stream and wheel will be installed, developing 6,700 hp additional. The pressure on the steel pipe is 1,100 pounds to the sq. in. The speed of the water leaving the nozzle is 25,000 ft., or more than four miles a minute. The cost of the plant will be about $600,000, and it will take the place of a fine steam plant built two years ago.

The outlet of Lake Isabel will be dammed, thus storing enough water for a six months' run. This is not necessary, but is a precautionary measure. May Creek is not large, but is a tumbling mountain stream flowing into the lake, and is never dry, so far as the oldest inhabitant knows. The company is now building roads to the lake, which is a little more than a mile from the Great Northern tracks.

Power Lines Near Ocean.

It is stated that the transmission wire of the United Electric Gas & Power Company, through Santa Monica, Cal., is to be removed from Speedway and carried back to Eighth Street, extended on to Redondo, San Pedro and Long Beach. The close proximity to the ocean, it is thought, has been the cause of the frequent sparking of the poles by the 22,000 volts carried through the wire. The company is reconstructing its transmission lines and using only iron poles in the new work.

New Telephone Patents.

IMPROVED SWITCHBOARD CONNECTING CORDS.

Wherever flexible electrical conductors have been required it has been well nigh universal practice to built them up out of numerous strands of small diameter. In telephone work tinsel strands have been largely used, and prior to the introduction of the common battery system such conductors were considered amply good for any service. With this modern system, wherever a continuous current is conducted, considerable annoyance may be experienced from the breaking of a few of the tinsel strands, the loose contacts at the break serving as microphones. To obviate this difficulty in switchboard connecting cords, which are subjected to great wear, a cord having single-strand conductors has been designed by Mr. H. B. Holmes, of Evanston, Ill. This is a three-conductor cord, the conductors being spiraled up in a manner such that while the whole is sufficiently flexible all bending takes place upon a radius of sufficient length to distribute strains.

In Fig. 1 is shown a section of cord partially fanned out to render the construction clear. It will be noted that a hemped string forms

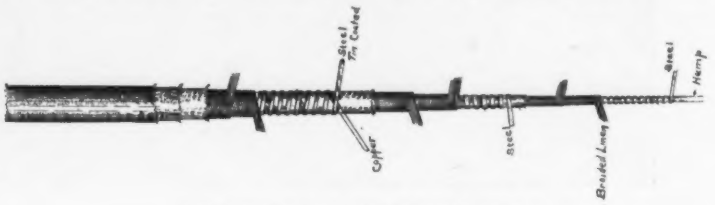


FIG. I.—HOLMES CONNECTING CORD.

the core. About this core a thin ribbon of spring steel strip .008 in. thick and .025 in. wide, tinned to prevent corrosion, is tightly wound making approximately twenty-two turns to the inch. Two layers of silk floss and a braid of linen follow. Then comes the second ribbon conductor, spiraled in the reverse direction from the first and making eighteen turns per inch. Floss and braiding follow, as for the first conductor. These two conductors have resistances respectively of nine and eleven ohms for a seven-foot cord and are to be used for the talking circuit.

Now follows the signal conductor, for which the resistance must be kept low in order not to disturb the current ratios of existing systems. This conductor consists of a copper ribbon wound on in one direction and a steel ribbon wound in the reverse direction, the copper lying beneath at four turns to the inch, and the steel at fourteen turns to the inch. This combined conductor has a resistance of two and a half ohms per seven feet. The cord is finished with braiding and reinforcing in the usual way. This cord is apparently of a construction to stand great wear and tear, and should have a life considerably greater than the tinsel cord. The Western Electric Company have obtained this patent by assignment.

CENTRAL ENERGY CIRCUITS.

A two-wire central energy system has been patented by W. M. Davis, of Chicago. A differential line relay is used, one winding of which is so arranged that it becomes shunted by the insertion of a plug in the associated line jack. The armature of the relay then, of course, comes up, thus opening the line signal circuit. The connecting cord circuit runs directly from plug to plug for one side of the line, while for the other a condenser is inserted to permit of the use of two supervisory signals. The supervisory relays which control the lamps through back contacts serve as retardation coils through which current is fed to the subscribers' lines. This arrangement of relay, of course, corresponds to a closed circuit for the lamps, when the cords are not in use; and, therefore, the lamp circuit must be opened independently of the relays by the removal of the plugs from the spring jacks. This is accomplished by making a portion of the circuit common for the lamp and for talking, this common portion including the plug and jack. Mr. Davis has assigned his patent to the Stromberg-Carlson Company.

NEW DESIGN OF JACK.

A two-wire system jack recently patented by Alfred Stromberg has also been assigned to the Stromberg-Carlson Company. This is designed for a system slightly different from that just described. This may be called a "bank" jack, being built in groups or banks of one hundred. Fig. 2 shows the construction fairly well. The front plate of hard rubber is shown at 1. The back plate, 5, in which the springs are mounted is built up of rubber strips. The jack thimble, it will be noticed, is not spun into position according

to standard custom, but is held by its conducting extension being riveted to one of the line springs. At the ends of the bank metal

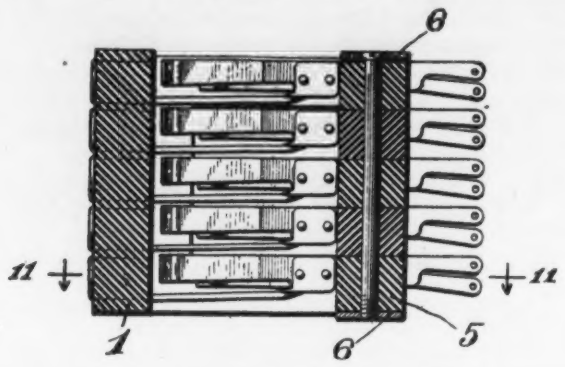


FIG. 2.—STROMBERG SWITCHBOARD.

spacing pieces are run across from front to back, to maintain the parts in their proper relative positions.

TRANSMITTERS.

Something quite peculiar in transmitters appears in a patent which has been issued to Pierre Germain, of France. This transmitter is provided with a heating coil which surrounds the carbon electrodes, the inventor stating that these work best when at about 80° C. Another feature is a supply of sodium or similar substance within the casing of the transmitter. This is designed to absorb moisture and oxygen to prevent corrosion of the parts. The third feature of note is the mixing of metallic oxides with the carbon of the microphone. In some cases it is mixed before baking; in others, after baking.

Two other transmitter patents relate to an instrument for the use of the deaf. The transmitter described is a double affair, being composed of what is practically two transmitters with their mouthpieces removed and their inlets opposed. Leading into these inlets are two curved sound passages, so shaped that two currents of air meet, the idea being to make the sound wave disturbances spread out over the diaphragms in virtue of the meeting of the two passages. The casing of each element is perforated with numerous small holes in a manner such that these serve to connect the outside air directly with the air spaces in front of the diaphragms. The inventor, H. G. Pope, of Brooklyn, N. Y., states that this perforation promotes clearness.

RECEIVER SUPPORT.

The receiver support has again appeared, this time in a form rather more commendable than some of those of earlier design. This support has an attachment engaging the hook switch in a manner such that the hook is not depressed except when the ear of the user is forcing it to one side. G. B. Buchanan, of Haverstraw, N. Y., is the patentee of this holder.

RINGING DEVICES.

An apparatus for ringing from subscribers' stations without the use of a magneto has been patented by O. O. Lee, of Chicago. Mr. Lee employs an auxiliary hook switch contact which is closed only when the hook is near the mid-position of its stroke. When this contact is held closed, a vibrator, associated with the induction coil, begins to move, rapidly breaking and making the primary circuit of the induction coil. The secondary sends out impulses of alternating current to the line. A rather powerful battery must be used for the ringing, a cell or two of this being used for the talking circuit.

Another ringing device is one patented by W. D. Watkins, of San José, Cal., designed for selective signaling. This is a step-by-step mechanism of very simple construction. The pawl operating armature is worked under the influence of the coils of the ringer while the selective device does not render any circuit changes necessary, being dependent upon releasing one bell hammer after another as the parts rotate, by the withdrawal of a stop which normally restrains its motions.

Two other step-by-step selective devices are subjects of patents in the issue under consideration. These are respectively the work of R. Hamilton, of Milton, Mass., and Messrs. H. Redmon, R. L. Hall and R. H. Conway, of Cynthiana, Ky. The apparatus and methods of operation of the two systems are markedly different, yet both involve merely the usual features of such systems, with the possible exception that special attention has been given to synchronizing all the instruments of a line after its use.

CURRENT NEWS AND NOTES.

LONDON STREET LIGHTING.—The most recent returns show that the streets of the 118½ square miles of London are lighted by 4,974 electric arc lights, 1,185 electric incandescent lights, 56,690 incandescent gas lamps and 18,248 flat flame gas burners. This leaves a lot of work ahead for electricity.

TELEPHONY IN CHINA.—For some time the introduction of the telephone in Canton, China, has been talked of, and is now said to be a *fait accompli*, the arrangement being in the hands of the Imperial authorities. All the large yamens will have the advantage of this new departure, and many large dealers and banks will also be provided for. It may not be generally known that some years ago the telephone was introduced in Shameen, but very high charges were made, and the enterprise proved a failure.

BRITISH TRAMWAYS.—During 1903 the number of passengers carried by the tramway system in the United Kingdom reached the number of 1,681,948,655, an increase of 287,495,672 over 1902, while the mileage had increased from 1,482 to 1,772 miles. The number of companies operating was 296. In 1894, 30,528 horses were at work in connection with the tramways in England; in 1902 the number was 24,120, but last year the total fell to 20,005, and the number is destined still to diminish, as the tramways are rapidly becoming electrified.

MORE SUBWAYS FOR NEW YORK.—The Metropolitan (Interurban) Street Railway system of New York has laid plans before the Rapid Transit Commission for a complete underground system to be operated under a 5-cent transfer system in connection with the 500 miles of Metropolitan surface line. Mr. Parsons is quoted as saying that the system will take about $40,000,000 to build, as compared with $35,000,000 for the Belmont subway now nearly ready for use. At the best, the Metropolitan system can hardly be ready before the growth of population has more than overtaken the new facilities.

PIPE THAWING IN NEWARK, N. J.—During the recent severe cold spell, the Street and Water Board of Newark, N. J., adopted the electrical method of thawing out water pipes. The transformer and rheostat were put upon a wagon and moved from place to place. When one service pipe was to be thawed out a wire was attached to a faucet in the kitchen or laundry and the other was fastened to a fire plug in the street. In five minutes the ice in the pipe thawed out to the main, and steaming water ran from the faucet. When two houses which were in trouble were close together, one wire was attached to the faucet in the first house and the other to that in the next. The frost went so deep into the ground that there was trouble all over the city, and the authorities cleared twenty or thirty pipes a day by this novel method. It was done gratis where the pipes have been laid from the mains to the houses by the city, which is the case with all that have been laid in the last ten years. Otherwise the cost was $5 or $10. By the old means of digging up the street it would cost from $25 to $50.

BOHEMIAN PITCHBLENDE.—Mr. N. J. Ledoux, United States Consul at Prague, Austria, writes as follows: "The government mines at St. Joachimsthal, which have become famous since the discovery of radium, are in Bohemia. In the course of the manufacture of uranium colors, the radioactive element of the pitchblende (radium, etc.) remains in the residue of the alkaline solution of patassium salt, which, since the discovery of the fact that it contains radioactive substances, is being evaporated and sold to chemical works and institutions of learning for the manufacture of radium preparations. The quantity of residue of alkaline solution of potassium salts amounts, according to the extent of the manufacture of uranium colors, to 11,000 to 17,600 pounds per annum. Orders for this residue should be addressed as follows: 'K. K. Bergwerksproduktion-Verschleiss-Direction, Vienna, Austria,' or to 'K. K. Berg-und Hüttenverkaltung, St. Joachimsthal, Bohemia, Austria.' There is, however, no pitchblende for sale now. Application should be addressed to the above-named officials for proper attention when any available supply is on hand."

NERNST LAMPS FOR ST. LOUIS EXPOSITION.—The Art Building interior at the St. Louis Exposition will be lighted by Nernst lamps. The white light of this lamp should adapt excellently to the illumination of paintings so as to give approximately a daylight effect.

WIRELESS TELEGRAPH INSTRUCTION.—The Navy Department is making preparations to transfer the wireless telegraphy school for enlisted men from Newport to the Navy Yard at New York, where better facilities are afforded for this work. It is intended to assemble there all men under electrical instruction, both in wireless telegraphy and other branches.

NEW CABLE TO JAPAN.—The *Bourse Gazette*, of St. Petersburg, commenting on the report that the United States has undertaken to lay a submarine cable from the Philippine Islands to Japan, to prevent the latter's isolation in case the Russians cut the Shanghai cable, makes a bitter attack upon the United States Government "for this new evidence of its breach of neutrality," claiming that the contention of the United States that the laying of the cable will be undertaken for the improvement of trade relations "does not clear America's skirts," and inquiring "what the Americans would say if Germany had run a cable from Kiaochou to Port Arthur or Vladivostok?" Washington dispatches on February 24 said that the Commercial Cable Company had addressed inquiries to the government as to whether permission could be secured to land on the island of Guam a cable connecting with Japan. This cable would connect at Guam with the present Pacific Commercial cable to the United States. It was said that the request was based on the apprehension that the existing Japanese cables, both of which run to Shanghai, might be cut during the present hostilities, and Japan thus be isolated from the world. In considering the request the government was said to have reached the conclusion that an assent would not involve a breach of neutrality, taking the ground that a cable is a commercial instrument like a mailship.

RUSSIAN TELEGRAPH CENSORSHIP.—The Russian Government has abolished the censorship upon all news and other telegrams going abroad. The lifting of the embargo, which has existed for generations upon the free transmission of news from the Russian Empire, came as a direct result of the consideration of the subject by the Czar himself, and in some respects this abolition is regarded there as the most important act since the emancipation of the serfs. Foreign telegrams, until recently, were subject to censorship at the Ministry of Foreign Affairs, but, since the death last autumn of M. Gretch, who was at one time connected with the Russian Embassy at Washington, the censorship has been temporarily under the Ministry of the Interior, where the permanent censorship bureau of plays, books and newspapers in Russia is located. News telegrams addressed to foreign sources originating in the most distant parts of the empire, Vladivostok, for example, were formerly telegraphed to St. Petersburg to be passed on. M. de Plehve, Minister of the Interior, and Count Lamsdorff, the Foreign Minister, both joined in the recommendation that the censorship be abolished. The internal censorship is to be retained, but foreign dispatches are to be entirely free. Inasmuch as a state of war exists, telegrams from the theatre of hostilities will be subject to the same kind of military censorship enforced in all countries under similar circumstances.

N. E. L. A.—Mr. Ernest H. Davis, secretary of the National Electric Light Association, reports that for the Question Box at the Boston convention, next May, nearly 300 questions for Mr. Hartman to get answered, have come in. The new active members of the Association are: Montgomery Light and Water Power Company, Montgomery, Ala.; Hot Springs Water Company, Hot Springs, Ark.; Monterey County Gas and Electric Company, Monterey, Cal.; Moscow Electric Light and Power Company, Moscow, Idaho; Freeport Railway Light and Power Company, Freeport, Ill.; Richmond Light, Heat and Power Company, Richmond, Ind.; Keokuk Electric Railway and Power Company, Keokuk, Iowa; Waterloo and Cedar Falls Gas and Electric Company, Waterloo, Iowa; The Electric Railway, Light and Ice Company, Junction City, Kan.; Clinton Gas Light Company, Clinton, Mass.; Great Barrington Electric Light Company, Great Barrington, Mass.; Edison Sault Electric Company, Sault Ste. Marie, Mich.; Edison Electric Light and Power Company, Amsterdam, N. Y.; The Allegheny County Light Company, Pittsburgh, Pa.; Newport and Fall River Street Railway Company, Newport, R. I.; Bristol Gas and Electric Company, Bristol, Tenn.; Burlington Light and Power Company, Burlington, Vt.; The Washington Water Power Company, Spokane, Wash. The new associate members are: Ford, Bacon & Davis, New York City; American Conduit Company, New York City; B. D. Nath, Schenectady, N. Y.; William Thomas Taylor, Schenectady, N. Y.

LETTERS TO THE EDITORS.

Steam Turbine Economy.

To the Editors of Electrical World and Engineer:

SIRS:—Referring to the article by Mr. A. N. Mattice in your issue of February 20, on the 1,250-hp steam turbine for the Interborough Company, the economies shown are certainly very good, but it is unfortunate that Mr. Mattice does not give the consumption of the auxiliaries, particularly the air and circulating pumps and superheaters.

Articles of this kind are apt to be misleading and as an illustration, the operation of a compound reciprocating engine by means of the air pump may be cited, where no steam is actually consumed by the engine itself, the work being done entirely by the "vacuum," i. e., atmospheric pressure.

We have been informed so many times by the manufacturers of turbines, of the necessity of high—in fact almost theoretical—vacuum, that it is somewhat of a question if the high economies claimed are not more than offset by the means adopted to obtain them; viz., the use of large air and circulating pumps, and super-heaters, etc.

CHICAGO. CYRUS ROBINSON.

Theory of the Repulsion Motor.

To the Editors of Electrical World and Engineer:

SIRS:—I have read with much interest the data published in the ELECTRICAL WORLD AND ENGINEER on page 266 and following, on the subject of repulsion motors of the General Electric Company. The information, as well as the discussion by Mr. Steinmetz confirms fully the elementary theory of the repulsion motor which I gave last year (see *Elek. Zeitschrift*, June 11, 1903), and which was later developed by several authors.

In the article referred to I pointed out the fundamental characteristic and that which decides the future of the repulsion motor; that is to say, in this motor there is produced a true revolving magnetic field which in itself suffices to insure a perfect commutation of the motor at normal speed. I am, therefore, convinced that the large motors of the General Electric Company, if they are satisfactorily dimensioned, will operate at normal speed with a commutation equivalent to that of the best continuous-current dynamos. Under the above conditions it is not necessary to establish a comparison between the repulsion motor and the ordinary series motor. In fact, an ordinary series motor of 100 hp, 25 cycles (I refer to a motor with a continuous output of 100 hp) has an impossible commutation. High-resistance connections between the armature leads and commutator undoubtedly improve the commutation, but not to a sufficient degree.

The repulsion motor is manifestly superior to the series motor at normal speed of operation, but conditions of commutation during the period of starting are the same for both motors. In this respect it is quite certain that the large motors of the General Electric Company commutate badly during the period of starting unless some special and novel arrangements have been adopted to avoid this effect.

The repulsion motor is the only serious competitor of my series compensated motor with power factor unity. Large motors built according to my design evidently present during the period of starting commutation difficulties which are the same as those of large repulsion motors. I have, however, discovered several new improvements which entirely overcome the defects for both kinds of motors, and I intend to describe these improvements later.

Concerning discussions of efficiency, power factor and weight of the ordinary series motor and the repulsion motor, I would say that they cannot bring forth any new results other than those which have already been obtained with single-phase induction motors.

PARIS, FRANCE. MARIUS LATOUR.

Single-Phase Alternating Current Motors.

To the Editors of Electrical World and Engineer:

SIRS:—My attention has been called to the luminous sketch contained in your issue of February 13 describing the widely heralded Westinghouse (Lamme) alternating-current railway motor. (Blow ye trumpeters, blow!) And I have read the entire article with much pleasure and some profit. ('Tis always pleasant to meet old friends.) The following startlingly novel discoveries are disclosed:

1st. With alternating currents laminate the magnetic circuits.

2d. To reduce secondary circuits in the armature circuits insert resistance. Formula, $I = \frac{E}{R}$. This failing, do something else.

3d. To reduce the inductance of the motor.—*A.* Decrease the applied frequency. *B.* Unwind the field coils. *C.* Demagnetize the blessed thing.

4th. To get good commutation—commutate.

5th. To make the motor work with alternating currents, make the alternating currents work the motor.

6th. To make it work better, patent it. (Don't patent it plainly, just patent it so the experts can have a chance to tell the truth.)

7th. If it looks a little old and seedy, get a new name plate.

From the above data I draw the following conclusions: There are two fundamental methods of producing inventions—first, make them; second, take them. Yours very truly,

WILLIAM STANLEY.

P. S.—If the above is not entirely clear—
Ask Weston about the multiple armature winding used about 1880.
Ask Kelly about the armature resistances used about 1891.
Look at patent No. 479,675, July 26, 1892, for the rest of it.
BROOKSIDE, February 20, 1904. W. S.

[Following is a reprint of the specifications, drawings and claims of Patent No. 479,675, issued July 26, 1892, to William Stanley, Jr., and John F. Kelly, on an application filed November 4, 1891, the title being "Alternating-Current Motor."—EDS.]

This invention relates, mainly, to electro-magnetic motors designed or adapted to be operated by alternating currents.

The special form of motor contemplated as within the limits of the applicability of the invention may be very widely varied; but for purposes of illustration the invention will be described as applied to any ordinary type of motor having a commutator and armature-winding similar to those existing in continuous-current generators and motors and a field magnet (which should be laminated or magnetically subdivided) energized by coils in series with or in derivation to the armature-circuit. If an alternating current be caused to flow through the armature coils of such a motor, it will, as is well understood, be subject to a given retardation, due to the self-induction of the armature. In fact, it has been found that this retardation may be and generally is sufficient to very seriously impair the efficiency of the machine. It may be corrected or neutralized in its effects and the trouble due thereto avoided by the employment in the circuit of a condenser of suitable capacity; but when the whole of the energy to be transmitted must pass through the condenser the latter becomes a large and costly adjunct and the apparatus as a whole becomes less available for general service. It will be understood that if on the armature a second winding were applied symmetrical with the first, but in which the current passes in a direction opposite to that of the current of the first, that no self-induction, and in consequence no lag, would result. With both windings attached to the armature-core, however, no effective torque would be developed, as it will readily be seen that each winding or coil would be impelled in an opposite direction. If, however, only one of such windings be made fast to the revolving armature-core while the other is fixed in space, the maximum torque is secured, while the self-induction is reduced to a minimum, since the two windings, as before, will neutralize one another, so far as self-induction is concerned, while the stress due to the field will be transmitted from but one of them to the core. It is not necessary that the two windings should be exactly alike, if only the magnetizing effects shall be approximately equal and opposite.

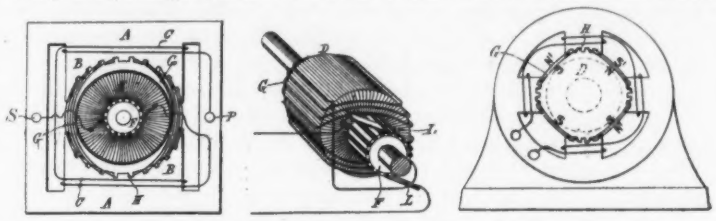
In direct-current motors and generators a somewhat similar disposition of coils to that above described has been employed to neutralize the magnetism imparted by the armature-coils and for the purpose of preventing change of lead; but as we propose to deal only with alternating-current machines we place our coils exactly parallel to the field magnetization and organize them so that they serve as anti-induction rather than anti-magnetization coils and close them upon themselves, so that they will be acted upon inductively by the moving armature-coils and, by the current generated therein, tend, so to speak, to check the rise of magnetism in the armature rather than its ultimate development.

The invention therefore consists in the combination, in a machine of the kind described, with the rotating armature and coil or coils thereon, of a stationary coil or coils closed upon itself or themselves, adapted to produce an effect approximately equal but opposite to that of the coil carried by the armature, whereby the self-induction and consequent retardation in the armature will be neutralized or overcome.

The plan or means by which the invention is carried out is illustrated in the accompaning drawings.

Fig. 1 is an end view of a motor embodying the invention. Fig. 2 is a perspective view of an armature, exhibiting, diagrammatically, the special winding which the invention involves. Fig. 3 is an end view of a multipolar field-magnet with the improvements applied to the same.

In Fig. 1, *A A*, represent the field-core of any ordinary motor; *B B*, the polar projections between which the armature is mounted,



FIGS. 1, 2 AND 3.—SINGLE-PHASE ALTERNATING-CURRENT MOTOR.

and *C C*, the energizing field-coils surrounding such polar projections. *D* is the armature-core, *E* the coils wound thereon, and *F* is the usual commutator. *G* designates the stationary coil. This coil is wound in convolutions parallel to those on the armature and are conveniently contained in recesses or grooves *H*, cut or formed in the faces of the pole-pieces.

The relations of the two armature-coils are better illustrated in Fig. 2. The armature *D* in this case is wound in the usual way, with a conductor laid parallel with its axis in coils connected with the segments of the commutator *F*. The line of commutation is shown by the position of the brushes *L L*, and the stationary coil *G* is shown as surrounding the armature, its convolutions being in planes at right angles to the line of commutation.

In Fig. 1 the armature and field-coils are in series and the stationary coil is closed upon itself. The stationary coil is shown more clearly in Figs. 2 and 3 as having its ends connected together, the coil being thus in closed circuit.

In Fig. 3 the field-core is provided with a number of pole-pieces, being, in fact, a type of multipolar machines. The stationary coils in this case are wound in grooves in adjacent pole-pieces, so as to produce an opposite magnetizing effect upon or in the armature to that of the armature-coils. For example, if the tendency of an armature-coil is to produce a north pole in its core at any given point, as *N*, the corresponding stationary coil will have an equal tendency to setting up at the same point an opposite pole. So, in general, where the armature-coils act to establish poles *N S*, the stationary coils neutralize such action by establishing poles *S' N'*, as indicated in the diagram. The stationary coils, *G*, it will be observed, do not sensibly affect the magnetic conditions of the field, owing to their position relatively thereto; but their magnetizing influence is manifested in the armature-core, where it opposes that of the armature-coils.

In practice the conductors of the supplemental or stationary coil or coils will be bent aside at one or both ends of the armature to permit the latter to be introduced in or withdrawn from the field-magnets, as is indicated in Fig. 1.

This invention is more particularly applicable to and useful with motors; but it may be used to advantage, when the machine is run as a generator, for preventing lagging of the current.

The claims are as follows:

1. The combination with the armature of an alternating-current motor and the energizing-coils wound thereon, of a stationary coil closed upon itself and having its conductors or convolutions substantially parallel to those of the armature-coil, whereby the self-induction of the armature will be neutralized, as set forth.

2. The combination, with the armature of an alternating-current motor having a commutator to which the coils wound on the armature are connected, of a stationary coil closed upon itself and having its conductors or convolutions substantially parallel to those of the armature-coil, whereby the self-induction of the armature will be neutralized, as set forth.

American Electrochemical Society Elections.

To the Editors of Electrical World and Engineer:

SIRS:—In common with most of the directors of the American Electrochemical Society, I signed a petition for a constitutional amendment, making the president, vice-presidents and managers ineligible for re-election. I must, therefore, decline to be a candidate for re-election to the office of vice-president, for which, I am officially informed, I have been nominated.

At the same time, in view of the very handsome vote which my friends have cast for me in nomination for the presidency of the Society, and of the fact that the board of directors are not endorsing any one for that office, I announce myself as a candidate for the presidency.

ANN ARBOR, MICH. HENRY S. CARHART.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Alternators in Parallel.—BOHLE.—An abstract of a paper read before the Leeds Section of the (British) Institute of Electrical Engineers, discussing the operation of alternators in parallel. He briefly discusses the methods for quickly damping oscillations which occur; they are either mechanical damping methods of the well-known device of Hutin and Le Blanc or similar methods. If, on account of sufficient fly-wheel masses, the fluctuations of energy supplied to the network are smaller than the fluctuations of energy of the crank effort diagram, damping is useless. But if there are small fly-wheel masses, so that the fluctuation into the network are larger than the fluctuations of energy of the crank effort diagram, damping will give good results. In other words, use damping with multi-crank sets, but not with single-crank sets.—Lond. *Elec. Rev.*, February 5.

REFERENCES.

Theory of Alternating-Current Generator.—PULUJ.—The conclusion of his mathematical article on the application of the circle diagram to the theory of alternating-current generators. He develops the equation of the power curve.—*Zeit. f. Elek.* (Vienna), February 7.

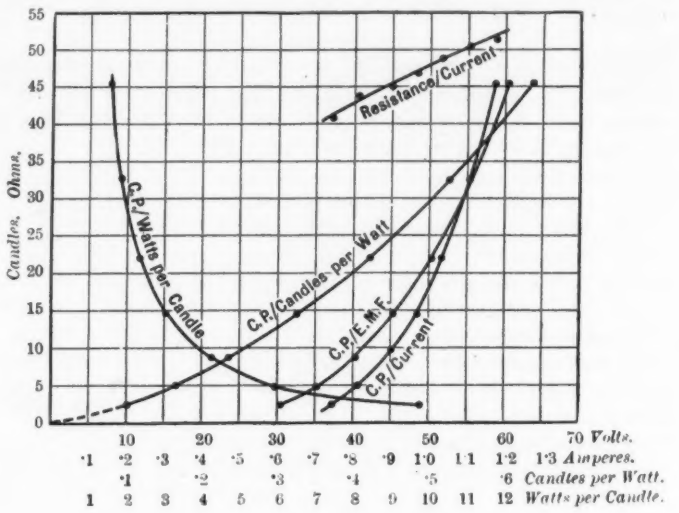
Theory of the Repulsion Motor.—CREEDY.—The first part of an article in which the author starts with a discussion of Steinmetz's symbolic method, in order to deduce later the circle diagram of the repulsion motor, and to give a general method of deducing the graphic theory of an alternating-current apparatus.—Lond. *Elec. Rev.*, February 5.

Single-Phase Commutator Motors.—LEHMANN.—A note on some special points in Blondel's theory of single-phase commutator motors, and especially on the repulsion motor diagram.—*L'Eclairage Elec.*, February 13.

Eddy Currents.—FIELD.—An article on eddy currents in dynamo machines. The author criticises several points of Thornton's recent paper and endeavors to show that the figures of his estimates cannot be right.—Lond. *Elec.*, February 5.

LIGHTS AND LIGHTING.

Osmium Lamp.—BAILY.—An article in which the author gives some results obtained with 55-volt, 32-cp lamps, made by the Vienna company which owns the Osmium lamp patents. There are three loops of wire, each anchored at the end, the total length of wire being 40 cm., with a diameter of 0.1 mm. The wire is very hard, and as brittle as glass, with a pale greyish-white surface. The variation between the five lamps tested in candle-power and efficiency was very slight. The average results are given in the adjoining diagram. In general the curves resemble those of the carbon filament lamp, but the agreement is not exact. The resistance increases with the temperature, while that of carbon between a red heat and a yellow heat slightly diminishes. Therefore, the watts absorbed, as the e.m.f. is raised, increase more rapidly for the osmium than for the carbon lamp. Nevertheless, the increase of candle-power is more rapid in the carbon than in the osmium lamp. Thus it varies as the sixth power approximately in the former, while the curve shown here is of the form cp = 0.0000035 multiplied by the fourth power of the e.m.f. The relation of efficiency (candles per watt) to candle-power for the osmium lamp is given by the equation efficiency = 0.065 multiplied by the 0.62d power of the candle-power, as against 0.028 multiplied by the 0.7th power of the candle-power for a carbon lamp. Thus, the improvement of efficiency is more rapid in the carbon lamp than in the osmium lamp. The important point about the lamp is its efficiency, which at the normal pressure of 55 volts is 1.9 watts per candle. Some favorable results, obtained by Wedding, as to life and maintenance of efficiency, are recorded; they were already noticed in the Digest. The cost of the high efficiency of the osmium lamp is stated to lie mainly in the higher temperature which the metal will stand, but it seems to be a slightly more efficient light radiator than the carbon, especially at lower temperature, although the ratio is probably reversed at higher temperatures. The color may be defined as similar to that of a carbon lamp running at 2.1 watts per candle. It is thought that the lamps should form excellent sec-



OSMIUM LAMP CURVES.

ondary standards of light, because of the whiteness of the light, the small deterioration of the candle-power, and, lastly, because of the smaller variation of candle-power with change of e.m.f., rendering error of adjustment of e.m.f. less serious than in the case of the carbon standard lamp. On this account they should be adjusted to a definite e.m.f., not to a definite current.—Lond. *Elec.*, February 12.

REFERENCE.

Theatre Lighting.—A fully illustrated description of the new lighting installation of the Drury Lane Theatre, in London. The equipment has been recently brought up to date to minimize danger of fire. The installation is described in detail, especially the switchboard and the regulators for stage lighting.—Lond. *Elec.*, February 12.

POWER.

Electricity in Mines.—A reprint in abstract of a report of the (British) Departmental Committee, appointed to consider the use of electricity in mines; also an editorial on the subject. The committee, while refusing to dictate as to which system of generation, transmission and distribution should be employed, clearly exhibits a leaning towards three-phase working. In one instance it is stated that a coal cutter, daily cutting 250 tons of coal, was driven by a three-phase

induction motor, and has worked well for some years; coal cutting is the most arduous work in coal mining. Dangers with the use of electricity in mines do exist, but they are much smaller than is generally imagined and accidents usually arise from faulty installations and careless or unskilled handling. The committee emphasizes the fact that no matter what the system may be or how high the voltage employed the whole installation should be considered a source of "potential danger." Except where electric locomotives are employed, or under other very special conditions, the committee do not consider an earthed return advisable. A warning is uttered against the overloading of cables by the addition of numerous subsidiary motors. —Lond. *Elec.*, February 5, 12.

Hoisting in Mines.—HERZFELD.—An illustrated article in which the author says that the sudden variation of load, which is one of the disadvantages of winding work, is felt much less with electric power distribution than with steam driving. In every case where electric driving has been adopted the cost of winding has been considerably reduced, and the larger the generating station from which the supply is obtained, the greater is the saving effected. He discusses the "Koepe wheel" and says that, for the same plant, a Koepe pulley coupled to an electric motor can be of about one-fourth the weight of a drum coupled to a steam engine. He believes that the Koepe pulley system with direct-coupled electric motor will be the system of the future. Some installations of German plants are described.—Lond. *Eng'ing*, February 12.

Electric Power in Ship Yards and Engine Works.—ANDERSON.—A paper read before the Newcastle Section of the (British) Institute of Electrical Engineers. He thinks that a combination of the three-phase system for power and the direct-current, three-wire system for lighting and special power purposes has the greatest advantages. For ordinary use he advocates the employment of the squirrel-cage induction motor. Since the wiring is not complicated nor expensive, squirrel-cage motors should always be used on such machines as punches, shears and beam benders, where the starting gear has sometimes to be placed at a considerable distance from the motor. On the other hand, for such machines as winches and cranes the slip-ring motor is the only one which will prove satisfactory. Details are given on power consumption of three-phase motors driving various machines in Newcastle.—Lond. *Elec. Eng.*, February 12.

Power Equipment of the Cleveland & Southwestern Traction System.—An article on this plant which is the first steam turbine installation for electric railway work in this country. A large portion of the system is provided for by the high-tension alternating-current system and eventually the entire road will be operated along these lines, but at present direct-current transmission is used for a portion of the system. In the main power house the direct-current units, aggregating 1,000 kw, occupy twice the space that the present turbine equipment requires, although the latter is double the capacity, or 2,000 kw. The turbines are of the Westinghouse-Parsons multiple expansion, parallel-flow type. Each system consists of three independent sections, namely, high-pressure cylinder, low-pressure cylinder and generator, the construction being explained in detail. In addition to the ordinary sub-stations located along the line the company has a portable sub-station which has been found very convenient in relieving the excessive load at particular points where there may be some unusual temporary demand for current.—*St. R'y Jour.*, January 30.

Electric Power in a Pianoforte Factory.—A description of the electrical equipment of a large pianoforte factory in London. A special advantage in electric driving in such factories lies in the fact that the manufacture can be carried on in a uniform direction, no transporting to and fro of partly finished parts from one tool to the other being necessary. Direct current at 230 volts is used, there being altogether 19 motors, nearly all totally enclosed (to prevent any danger of fire) and ranging in power from ½ to 26 hp. Some have been adopted for directly driving the various machine tools such as saws, polishing lathes, planing machines, etc. Others serve to drive short lengths of shafting.—Lond. *Elec.*, February 5. A longer illustrated description is given in Lond. *Elec. Eng.*, February.

REFERENCES.

Curtis Turbine.—SAMUELSON.—An abstract of a paper read before the Rugby Engineering Society. Several illustrations, giving comparative views of various turbo-generator sets and comparative elevations of engine-driven and steam turbine sets, and some diagrams showing the effect of different degrees of vacuum and expansion upon the steam consumption are reproduced.—Lond. *Elec.*, February 5.

Steam Meter.—BAYNTUN.—An illustrated description of a meter designed to measure and record the weight or quantity of steam passing through a pipe. By its means the rate at which a boiler is raising or an engine using steam may be read directly off a scale, and, by the addition of a recording drum, continuous record may be kept from which the total weight passed in any given time may be ascertained. The meter is essentially a volume meter.—Lond. *Elec. Rev.*, February 5.

Boiler Room Practice.—EDWARDS.—An article containing valuable suggestions regarding the care of boilers and their accessories.—*Am. Elec.*, February.

TRACTION.

Accumulator, Third-Rail and Three-Phase Traction in Italy.—LANINO.—A long account of the results obtained on four Italian railroads with electric traction. The first road is from Milan to Monza (13 km.), with storage batteries on the cars. The motor car, used on this road, had a weight of 58 tons, of which 20 tons were the weight of the battery (Hensemberger-Planté type) and could develop 100 hp with an average speed of 35 to 40 km. per hour and an acceleration of 2 to 6 cm. per second at the start, one charge of the battery being sufficient for a run of 50 train km. The system was found to meet in general the requirements of normal service, but not those of rush service on holidays, since there was only a limited number of motor cars available. The financial results were good, the cost of operation being 16.25 cents per car km. The energy consumption was 65 watt-hours per ton km. The maintenance of the plates caused an expense of 7 cents per ton km. The cars running on the road from Bologna to San Felice had a weight of 15 tons and could forward 75 passengers; with a battery of 12 tons weight with one charge they could run 100 km. and draw a 15-ton trailer on the first half of the line. The average speed was 45 km. per hour on a road with grades up to 0.3 per cent. The positive battery plates lasted more than 12,000 train km., the negative ones more than 20,000 ton km. The cost of maintenance of the battery was 6.08 cents and the total cost of operation 11.15 cents per train km. Thus the economical and technical results were must better than had been expected. In spite of this the operation with storage batteries was completely discontinued, partly by the influence of some railroad officials and partly because the service was not "elastic" enough to fulfil the requirements of very heavy service at certain hours. On the Milan-Varese-Porto Ceresio road (75 km. of which 60 km. are double-track) the third-rail system with 600-volt direct current is in use, the transmission of power being 12,000-volt three-phase current. The success of this line has been complete, there being no serious accident on account of people coming into contact with the third rail. "This fact is the more remarkable since the third rail, although properly protected from contact, runs through all stations, including a considerable number of tracks in the interior of the hall of the central station in Milan." Attention is called to the fact that in Italian stations the tracks are on the same level as the platform and that passengers have often to pass over the tracks. In very cold winter and in spite of heavy snow falls there was no difficulty with the third rail. The loss of current per km. of road was 0.06 to 0.07 ampere in dry air, and 0.11 to 0.12 ampere in moist air. The fourth road is the Valtellina line, on which 20,000-volt, three-phase currents are used for transmission to transformer sub-stations, which reduce the voltage to 3,000. The motor cars are provided with 3,000-volt, three-phase induction motors and tandem connection is used to get a second speed. This system has also been very successful. The author remarks that there is no competition between the third-rail, direct-current system and the three-phase system. The service on the third-rail road is characterized by many light trains with good acceleration; that on the three-phase road by heavy trains in longer intervals. The first is similar to a street railway; in the latter low first cost of installation and high efficiency are essential conditions. The author believes, however, that the future of electric traction belongs to the series motor.—*Elek. Zeit.*, February 11.

Third-Rail Shoe.—A description of the new third-rail shoe on the Boston Elevated, which differs radically from any other shoe in use on third-rail work. It consists of a soft steel bar, weighing about 5 kg. This bar, which is the portion used for making the contact with the third rail, rests in a hanger at each end and is held down

by its own weight and also by a light steel spring, which is constructed to give a downward pressure of about 23 kg., making a total pressure between the shoe and rail of 28 kg. without regard to the motion of the shoe along the rail. When the car moves, however, it tends to bunch the shoe up and compel it to make harder contact with the third rail at one end, depending on the direction in which the car is moving. The life of the shoe is about 21,600 km. A feature of the shoe is that it does not jump at joints.—*St. R'y Jour.*, February 6.

REFERENCES.

Collector for Single-Phase Cars.—An illustrated description of this collector which is manufactured by the Oerlikon Company and consists of curved rod having its convex face in contact with the power wire. The collector can move through an arc of 180°, so that the power wire can be in almost any position. The advantages of the apparatus were noticed recently in the Digest (abstract of Herzog's paper). Two diagrams are given showing the universality of the application.—*St. R'y Jour.*, January 30.

Contact Rail System.—Del Mar.—An illustrated article dealing with the practical problems with which a draftsman has to contend when preparing to lay out a system of contact rails for railways about to be converted from steam to electricity.—*Am. Elec.*, February.

Electrification of a British Railway.—An illustrated article on the electrical equipment of the Tynemouth lines of the Northeastern Railway, a third rail and the Thomson-Houston multiple-unit system being used. The power house will contain two 2,000-kw and two 3,500-kw Parsons turbo-alternators.—Lond. *Elec.*, January 22.

Conneaut & Erie Interurban System.—A description of this line, which is 56 km. in length, and forms the connecting link between Buffalo and Toledo and Detroit. Snow falls quite heavily in this region and the company has the second largest rotary plow in the United States, provided with four axles with four General Electric 100-hp motors on the trucks and a 200-hp motor to drive the fans. The power station contains two 400-kw generators and a booster for 375 volts and 300 amp. Polyphase transmission is not used.—*St. R'y Jour.*, February 6.

Rating of Stations.—Bond.—A paper on the rating of tramway and light railway undertakings. The paper deals mainly with English legal conditions.—Lond. *Elec.*, January 29.

Installations, Systems and Appliances.

British Central Station.—A description of the municipal station of Chesterfield. The direct-current, three-wire system is used. There are two 100-kw and two 200-kw generating sets and a battery of 280 cells with a rated capacity of 60 amp. for 10 hours and 300 amp. for one hour. In the years 1902-3 a total of 208,316 units was sold, the works costs being 1.64 cents per unit sold, and the total cost 2.74 cents. The current is mostly used for lighting, but the demand for motors is increasing, an equivalent of 170 hp being at present connected to the mains.—Lond. *Elec. Times*, February 4.

Wires, Wiring and Conduits.

REFERENCES.

Calculating the Capacity of Overhead Lines and Cables.—Lichtenstein.—The first part of a mathematical article in which the author develops approximate formulas for the capacity of parallel overhead wires for direct-current, single-phase current and three-phase currents, and for concentric two-phase and three-phase cables. The method, used by the author, is a generalization of Kelvin's principle of electric images. On account of its mathematical character, it is impossible to abstract the article briefly.—*Elek. Zeit.*, February 11.

Cable Works.—A fully-illustrated description of the cable works of Pirelli & Co., in Milan, which is stated to be the first firm in Continental Europe to manufacture submarine cables. The works are described under the following headings: Manufacture of washed rubber, spread sheet, cut sheet, calendered sheet, preparation of compound rubber for wires, manufacture of India rubber wires and cables, manufacture of dry-core telephone cables and manufacture of electric light cables.—Lond. *Elec. Rev.*, February 5.

Conduit Work.—Weeks.—An illustrated descriptive article on conduit work. The information is very practical in its nature and many valuable hints are given on conduit installation.—*Am. Elec.*, February.

Electro-Physics and Magnetism.

Evolution of Helium from Radium Bromide.—Dewar and Curie.—An account of observations, quite analogous to those of Ramsay, who observed a change of radium into helium. Some radium bromide weighing 0.4 gram was left for three months in a glass tube, communicating with a small vacuum tube and a mercury manometer. There was a continual slow evolution of gas, but the spectroscope showed nothing but hydrogen and mercury vapor. The same specimen was then taken by Dewar to the Royal Institution, where it was sealed up in a quartz tube and fused, the gases evolved being drawn off and examined with the spectroscope. Nothing appeared to be present except nitrogen. After thoroughly clearing off all the gas the tube was sealed up under the oxyhydrogen flame and sent back to France. About 20 days afterward Deslandres examined the tube with an induction coil, connecting it up by means of two pieces of tin-foil attached to the ends. He found a spectrum, not of nitrogen, but of helium, and that in its entirety, no other lines appearing on the plate even after an exposure of three hours with quartz lenses. The permanent luminosity of the tube only showed a continuous spectrum.—*Comptes Rendus*, January 25; abstracted in Lond. *Elec.*, February 12.

Selenium Cells.—Pfund.—While according to Bidwell the sensitiveness of a selenium cell is due to the presence of selenides in selenium, the present author concludes from a series of experiments that the sensitiveness is due rather to some direct action of light upon the selenium itself. It may be that light in falling upon selenium changes its crystalline character, and that the new modification of selenium is stable only in light, so that it reverts to its original condition when light is cut off.—*Phil. Mag.*, January.

REFERENCES.

Electromagnetic Theory.—Kolacek.—A mathematical note on the ponderomotive forces to which a homogeneous dielectric is subjected in a variable electromagnetic field. The author suggests experiments which would decide the correctness of either Maxwell's or Lorentz's theory.—*Phys. Zeit.*, January 15.

Impedance.—An illustrated didactic article on reactance, impedance, angle of lag and phase difference. All of these phenomena are minutely explained.—*Am. Elec.*, February.

Electro-Chemistry and Batteries.

Electroplating upon Aluminum.—Burgess and Hambüchen.—The principal difficulty in the deposition of a metal coating upon aluminum is as regards its adherence, and this is due to the very thin film of oxide which is always present on an aluminum surface. The authors first clean the aluminum by immersion for a few minutes in a dilute hydrofluoric acid bath where it remains long enough to produce a suitable roughening of the surface. Upon removing the aluminum from this bath it is rinsed in running water and then dipped for a few seconds in a mixture of sulphuric acid and nitric acid, both concentrated. It is then transferred to the zinc plating solution, which is a slightly acidified mixture of zinc and aluminum sulphate, with about 1 per cent. of hydrofluoric acid. Electrolysis is made for about 10 or 15 minutes with a current density of from 10 to 20 amp. per sq. ft. A coating of copper or silver from cyanide solutions may then be applied.—*Electrochem. Ind.*, March.

Electrochemical Equivalent of Silver.—Van Dijk and Kunst.—An account of the results of a redetermination of the electrochemical equivalent of silver. Former researches of various investigators have yielded results varying from 0.011156 (Mascart) to 0.011195 (Pellat and Leduc). The present authors used a tangent galvanometer for determining the strength of the current. Owing to the high degree of accuracy with which the constant of the instrument and the horizontal intensity of the earth's magnetic field and its space and time variations may be determined, this method is well adapted for a laboratory which has been built without iron, and in a place where no vibrations or stray currents in the earth are to be feared. The authors adopted Kohlrausch's bipolar method. The cathodes consisted of platinum, being either cup-shaped or in the form of a cylinder ending in a hemisphere. A silver rod served as an anode. Two voltameters were placed in series in order to insure that no irregularities occurred in the deposition of the silver. The final mean value obtained from 24 measurements was 0.0111818, which the authors believe to be accurate to within one part in 10,000. (The above figures are taken from the Lond. *Elec.* If the electrochemical equivalent is given in

divided by 10. The value adopted by the Chicago Electrical Congress is 0.001118 gram per coulomb.)—*Proc. Akad Wet.*, Amsterdam, January 21; abstracted Lond. *Elec.*, February 5.

REFERENCES.

Action of Light on the Formation of Accumulators.—TOMMASI.—An article in which he describes some experiments which show that the negatives of an accumulator form more rapidly in the light than in the dark, and that the positives form more quickly in the dark than in the light, other things being equal. The capacity, however, is found to be practically unchanged.—Lond. *Elec. Rev.*, February 12; *L'Eclairage Elec.*, February 13.

Resistance Furnace.—HERAEUS.—An article in which the author, in form of a reply to Guntz, gives some details of his resistance furnaces for laboratory work, in which around the heating tube very thin platinum foil is wound.—*Jour. Chim. Phys.*, January.

Electrolytic Analysis.—PAWECK.—An illustrated description of some improvements in electrolytic analysis, dealing especially with the use of revolving electrodes.—*Elektrochem. Zeit.*, February.

Progress in Electrochemistry.—KERSHAW.—A summary of the progress in electrochemistry and electrometallurgy in 1903, giving briefly the developments in the different industries.—Lond. *Elec. Rev.*, February 5, 12.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Names of Units.—TEICHMÜLLER.—A long communication in which the writer discusses the advisability of new names of units, proposed at the suggestion of Dr. Kennelly by the American Institute of Electrical Engineers to the next International Electrical Congress. In discussing new names, the question is not whether they are really needed in practice or in commerce, since they may be applied later extensively, even if they appear superfluous at present. He says that many considered the name mho horrible when first proposed, but did not oppose it, since they thought the name would not be used; at present the name mho has become so familiar that opposition would now be fruitless. Concerning the new proposals of the American Institute he thinks that the names do not sound well, and that the lack of harmony, which has been brought into the system by the names of gauss and maxwell, will become worse in future. For, later on, all names of the absolute units may have the prefix ab, but not gauss and maxwell, nor gilbert and oersted. In agreement with Hospitalier, he, therefore, suggests to adopt the following names for absolute units: e.m.f., centimicrovolt; resistance, millimicrohm; current, decaampere; electric quantity, decacoulomb; capacity, kilomegafarad; coefficient of self-induction, millimicrohenry; power, decimicrowatt; energy, decimicrojoule. While these names are rather long, he thinks they are not worse than many names of organic chemistry. He thinks the American Institute is fully justified in wishing names to be adopted for the linear integral of magnetic force and for reluctance. He thinks it is unfair that five English names should be used for units against two each of German and French and one each of American, Italian and Danish scientists. He urges to adopt the name of weber instead of gilbert.—*Elek. Zeit.*, February 4.

Ammeters with Adjustable Sensitiveness.—FEUSSNER.—A long illustrated description of an ammeter which consists of a millivoltmeter with shunt. The millivoltmeter has, besides the ordinary two binding posts, a third one by means of which a small part of the series resistance may be disconnected. The shunt is designed so as to have seven steps. By means of a switch with revolving handle, the instrument may be adjusted so as to give readings according to these seven steps. The lowest sensitiveness corresponds to 1 scale division equal to 1 amp., the highest sensitiveness to 1 scale division equal to 0.01 amp. The switch is operated without any sparking, so that when one takes a reading one may pass from one sensitiveness to another one without interrupting the current or changing any wires. The construction is described in detail.—*Elek. Zeit.*, February 11.

REFERENCE.

Insulation Testing Set.—A brief illustrated description of a very compact insulation testing set made by a British company. It is intended for carrying out insulation tests on the direct-deflection method and consists of a sensitive moving-magnet galvanometer, a resistance of 10,000 ohms and a set of 1/10, 1/100 and 1/1000 galvanometer shunts.—Lond. *Elec.*, January 22.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Cable Department Accessories.—COAR.—An illustrated article describing a number of articles used in a telephone cable department. A drip pan is shown, which eliminates many of the difficulties attending the boiling-out process. In most boards for making cable forms an arrangement of pegs or nails is used to terminate the different wires. A board which has some advantages over this method is illustrated. Instead of using pegs, holes are bored through the board, which enable the form to be laced more readily and also permit the insulation to be pealed from the wires without altering the shape of the form. A box for holding tags, preparatory to marking the different wires of a cable, which presents some advantages over the old methods of stringing the tags together or hanging them on hooks fixed in a marked board, is also described. A cableman's telephone circuit is shown, and a method for testing out conductors in a cable, which is applicable to both live and dead lines, is described.—*Am. Elec.*, February.

Trunk Exchange.—A fully illustrated description of the new trunk exchange of the post-office telephone service, which provides for telephonic communication between London and provincial and continental towns. There are positions for 42 trunk operators. Each switch section is divided into three panels, controlled by two operators. Five trunk circuits terminate on each of the outer panels, which also carry the multiples of the junction circuits serving the minor local exchanges. The junction circuits of the principal local exchanges are multiplied on the middle panel of each section, where they are accessible to either operator. Transfer circuits for interconnecting trunk circuits are provided on each of the trunk panels, as well as foreign, reserve and the usual official circuits. Apparatus is also provided for terminating a number of local subscribers' circuits which are used only for extensions to the trunk system.—Lond. *Elec. Rev.*, February 5, 12.

Railway Signals.—An article on the Hall electrode-gas signalling system, which will soon be introduced on a section of 11 miles of the North Eastern Railway Company, of England. While in European practice the semaphore signal was heretofore worked by an electric motor, carbonic acid gas has now been adopted as motive power. The gas is admitted into cylinders containing pistons attached to the upright rods. The valves controlling the admission of the gas into the cylinders are opened and closed by the armature of an electromagnet, which is energized in the usual way by a local circuit controlled by the relay of the track circuit.—Lond. *Elec. Rev.*, January 22.

Railway Telephones.—An illustrated description of telephones for railway use. Two types are shown, one being an iron box telephone to be attached to the poles along the line and the other being a portable car telephone encased in a wooden box with a leather strap for carrying. This instrument is fitted with a long cord, at the end of which is attached a plug for insertion in jack boxes. These jack boxes may be installed on poles along the line and communication had with the central office by plugging in at these points. The cord is long enough to allow the motorman to leave the instrument in the car.—*St. R'y Jour.*, February 6.

Tramway Signal System.—A description of an electromagnetic signal system using two solenoids for operating the semaphores. When the car enters a block it makes contact with a plate on the trolley wire. This contact closes a circuit operating the main solenoid. The energized solenoid pulls up the semaphore, which is then held in place by a catch. When the car reaches the end of the block, contact is again made through a second plate and current flows to energize the second solenoid. The latter pulls back the catch, thus causing the semaphore to fall back to safety position.—*St. R'y Jour.*, February 6.

MISCELLANEOUS.

REFERENCES.

Manufacturing Plant.—A fully-illustrated description of shop No. 3 of the Bullock Electric Manufacturing Company.—*Mach'y*, February.

Obituary.—An account, with portrait, of the life and work of W. G. McMillan, the late secretary of the (British) Institution of Electrical Engineers.—Lond. *Elec. Rev.*, February 5.

New Books.

MESSUNGEN AN ELEKTRISCHEN MASCHINEN. By Rudolf Krause. Berlin: Julius Springer. 158 pages, 166 ill. Price, 5 marks.

This is a capital little book on engineering measurements and tests of dynamo machines from an electrotechnical standpoint. Polyphase dynamos receive especially full treatment.

The first chapter is devoted to measuring instruments generally. Their elementary mathematical theory is well outlined from the engineer's viewpoint. The theory of the modern hot-wire voltmeter and ammeter is given here for the first time so far as has come to our notice.

The second chapter considers the electric power measurements of alternating-current generators. The third chapter deals with temperature changes of resistance and their measurement. The fourth chapter deals with measurements of frequency and the fifth with the measurement of insulation and conductor resistances. Magnetic measurements are followed in the sixth chapter and in the seventh tests for efficiency and regulation are considered, also tests for temperature elevation and torque. The eighth chapter relates to the measurement of losses in machines by tests on open circuit. The ninth chapter deals with the measurement of the wave form of voltage and current in alternators. A brief final chapter considers standard tests of machines and their formal tabulation.

The book is an excellent compendium of polyphase tests according to German practice. It does not contain many of the methods that are adopted in other countries. It will be found of much value to students of electric machine testing.

WIRELESS TELEGRAPHY. By Charles Henry Sewall. New York: D. Van Nostrand Company. 229 pages, 85 illustrations. Price, $2 net.

Mr. Sewall puts forward his admirable book very modestly. It is intended for the general public as well as for the technical student. There is growing up a specialized literature on wireless telegraphy, so that the expert has to, and in fact prefers to, restrict his range of study; but there are many points and much data in this volume that render it an exceedingly useful book to have handy in an electrical library. Not the least interesting part of this nature is the chapter devoted to Mr. Tesla's work. It is the first connected story of the kind on any work of Tesla's, since the book by Martin, issued away back in 1894, before Mr. Tesla had begun to carry out even experimentally the theories and ideas with which he had even then been so daringly profuse as to wireless transmission, not only of intelligence but of actual energy. It may be a close guess that the author had Mr. Tesla's help on this fascinating chapter, which somehow seems to leave the reader "in the air," but is full of deep suggestiveness and is generously illustrated.

Mr. Sewall is certainly liberal and eclectic in his methods, for while he thus takes us up into the ambient wireless air with Tesla, he also plunges us into the depths of the sea with Pupin's coils, as applied to ocean cables. At first the propriety of the juxtaposition is hardly realized, but after all in a comparison of rival methods the matter has its place in such a book, and many will welcome it. They will also welcome many other quite unexpected little plums, not forgetting the portraits of several leaders in the wireless field. Mr. Sewall has been fair, industrious and broad-minded, and we hope his reward will be reaped. The publishers may be congratulated on the handsome shape in which the book is put forth.

MAVER'S WIRELESS TELEGRAPHY. By Wm. Maver, Jr. New York: Maver Publishing Company. 216 pages, 123 illustrations. Price, $2.00.

The fact that this book is written by one of the foremost telegraphers of America, whose encyclopædic work on American telegraphy is already a standard, will suffice to insure for it a warm welcome. But Mr. Maver has not merely traded on his reputation and thrown together a haphazard catch-penny volume, to meet the sensational demand of the hour. With his usual thoroughness and clean-cut style, he has taken up the subject in a highly practical manner, soberly and seriously, giving space, it is true, to theory, but going straight for practice. It is here that Mr. Maver excels. He can himself theorize as well as do justice to the philosophies of others, but he is at his best when discussing and dissecting circuits and apparatus. In fact, much encouragement is to be derived from the issuance of such a book. We realize of a sudden that, beset as it may be by a dense mass of ill-digested theory and of loose statements that explain nothing, a new art is upon us and is being legitimately practiced.

Chiefly to be commended in addition to the lucid descriptions are the excellent diagrams and drawings. We have an idea that Mr. Maver likes to work a thing out thus on paper for his own guidance and comprehension; and he succeeds just as well with wireless conditions as he has done in the past with metallic circuits and the apparatus on which he spent his own life as a telegrapher. Another point is that all the various plans, schemes, inventions and apparatus now struggling for supremacy are set forth in a strong, dry, white light, with full impartiality. The index is most complete and praiseworthy, and we like also the business-like closing chapter of practical suggestions on wireless signalling. We would recommend every telegrapher to read this book, but it will find a large public also outside the telegraphic ranks.

ELEMENTE DER ELEKTROTECHNIK. By Moriz Kohn. Leipsic and Vienna: Franz Deuticke. 108 pages, 121 illustrations. Price, 2.50 marks unbound.

This little book contains a series of ten lectures given before a mining association at Pilsen. The conditions under which the course was held prohibited mathematical treatment and required all the subjects to be selected and presented with reference to practical electrical work. Ordinarily, these requirements would have rendered the work of an author so commonplace and colorless that there would have been no reasonable motive for publication except for circulation among that class of workmen for whom they were designed and delivered.

The present book, however, has a real interest for the reader. Its author is a professor in one of the excellent national industrial schools, which are now such a prominent factor in German education. He has come to his task of simplification with a firm grasp on exact technical knowledge; and, moreover, he has accommodated his subject to a class for whom he must select only the vital elements of technology, and bring them within the comprehension of those unskilled in mathematics. This will indicate the scope of the book and suggest its usefulness.

The lectures as a whole are admirable in the selection of subjects and topics, and the treatment is clear and concise. The matter of the book would have gained had it been less descriptive, and been emphasized by more frequent numerical examples. The illustrations are wholly diagrammatic, and they are exceptionally clear and well conceived. One illustration, in particular, is novel and more clever than the usual cumbersome mechanical analogue. The displacement of phase between two functions is illustrated by a device of two pistons in tandem with a spring connection between them. The frictional resistance of the head piston of the diagrammatic tandem engine perfectly represents the lag of the current in an alternating circuit. A surprising statement is made regarding the efficiency of large direct-current dynamos, where the value is given between 70 and 90 per cent.

The subjects discussed are the direct and alternating-current dynamo, the transformer, rotary converter and the accumulator. To those readers who are familiar with that excellent class of German works of which Keck's "Graphische Statik" may be instanced as a representative, this book by Kohn needs no further commendation than to include it in the number.

Radium in Cancer Treatment.

By advices from London it appears that both Dr. G. H. Plimmer, who has returned from a study of radium cures under the care of Prof. Etner, in Vienna, and Dr. Snow, of the Brompton Cancer Hospital, are very sceptical as to its results, the latter characterizing cancer as remaining "the darkest Africa on the map of medicine."

Dr. Snow, who has had vast experience in the treatment of cancer, in what probably is the last address he will deliver at Brompton Cancer Hospital, the other day pointed out that cancer is not one, but is constituted of many diseases. He said that the radium treatment had proved exceedingly disappointing and, in fact, it might now be dismissed from the sphere of potential cancer cures. At Brompton Hospital, he added, they had studied cancer as it had been studied nowhere else in the world. They had sought to investigate it from every conceivable point of view. They had labored by every means in their power to substitute for the mass of chaotic confusion and the traditional fallacy which had hitherto prevailed a genuine cancer science as a sure foundation for all future research; but in this attempt they had utterly and miserably failed.

Unique Fire Alarm Switchboard on Staten Island, N. Y.

An improvement in telegraph switchboard construction has lately made its appearance in the shape of a new board built for the fire alarm system of the New York fire department, Borough of Richmond, New Brighton, Staten Island. The board is constructed of non-combustible material and embodies all the latest and most desirable points to insure prompt results and absolutely sure and reliable working.

The new board is so constructed that the only part liable to combustion is the insulation on the wire, of which there is very little in evidence, omitting the magnet wire on the relays and the rubber knobs on the keys. The entire board is built of a frame of heavy steel tube. The method of construction is that each section of tubing is threaded right and left hand and is screwed into the fittings in such a manner that it may be at any time dismantled and moved to another location should it be desired. All panels and counters are of slate 1¼ in. in thickness. The switchboard is arranged for the accommodation of 14 box circuits and 8 gong circuits. All the apparatus applicable to each circuit is mounted upon a separate panel. These panels are removable without disturbing the other parts of the board. This in itself is a step in the right direction for one reason that in case of trouble arising in the operation of a fire alarm system it is of the utmost importance to be able to repair it in the shortest possible time.

The system adopted in the New Brighton board for announcing the circuits is simple and is as follows: Connected in each circuit panel is an annunciator consisting of a bull's eye of ground glass on which the number of the circuit is painted. To the rear of this is a 4-cp incandescent lamp, which lights up in case of the circuit opening, thereby visibly throwing up the number of the circuit.

Another novel feature is the arrangement of the relays. All relays are made on the same general principle and are non-combustible. They are mounted on the back of the panels, the working points of the armatures protruding through to the front. All circuits are provided with jacks similar to those employed in the telephone systems, so that by the introduction of a plug it is possible for the telephone operator to connect any of the circuits, thereby enabling him to hold conversation with men on the line who may go to any box on the circuit and call up the central office. It is possible to hold conversation over these telephones during signalling transmission from a box.

One of the principal features in connection with the board are the test panels for each circuit to be seen on the right of the switchboard. Each circuit has one test panel upon which is mounted an ammeter, transfer battery switch, pole changer and bridge. The ammeter denotes at all times the strength and direction of the current on the wire. The pole changer enables the operator, by the simple moving of a key to throw on a battery in case the main battery becomes inoperative. The bridge is arranged so that the operator by the movement of plugs similar to those in use in a Wheatstone bridge can change the polarity of the current and make any tests promptly. In addition to these test panels a novelty has been introduced on one of the lower panels, which is certainly a time-saving device so far as testing for cross lines is concerned. Heretofore it has been the practice to move a plug or a switch individually on each circuit, for the purpose of testing for crosses, thereby consuming a considerable amount of time; and in large stations where the business is somewhat heavy, the pursuing of such method has made it possible to lose an alarm. This is overcome in the New Brighton board by each circuit being connected to a dead spring point. These points are arranged in a circle and are covered by a plate which is capable of being pushed into contact with all the points except one, a knotch or section sufficiently large to miss making contact being left in the plate, thereby enabling the operator, by the simple operation of pushing the plate to make the necessary test in a few seconds instead of one or two minutes.

FIRE ALARM SWITCHBOARD AT NEW BRIGHTON, STATEN ISLAND.

Another unique departure embodied in the new system is the multiple pen register for the reception of all signals transmitted. This register is so constructed that all springs, adjustments, pens and ink rolls are independent and easily reached by the insertion of the hand in front of the register. Each pen has an independent ink roll. With a solid ink roll the whole affair has to be taken apart should one pen get out of order.

Yet another new feature of the Staten Island system is that all the wiring and connections are in full view of the operators. Provision has also been made so that during the transmission from a fire alarm box it is at the option of the operator, by the movement of a switch, to throw in repeating apparatus that will transmit automatically gram per coluomb all the above figures for the equivalent are to be

direct from the box to the gong or fire house circuits. This is not as a rule depended upon, but is used only in exceptional cases, for the reason that should an error occur it will be transmitted, and the principle of all manual central stations is that mistakes of this kind cannot take place.

The switchboard was designed by Mr. Henry E. Vineing, the electrical engineer of the New York fire department. It was built by Foote, Pierson & Co., 82-84 Fulton Street, New York City.

English Form of Continuous Current Prepayment Meter.

The success of the prepayment gas meter has been generally accepted as indicating that a large sphere of usefulness exists for prepayment electrical meters. The prepayment meter possesses several advantages, among which may be mentioned the avoidance of the perpetual trouble of writing for accounts to be settled, and the reduction of bad debts to a minimum. To the user it offers a great inducement in so far that small payments extending over a protracted period can be made. The British Thomson-Houston Co. has achieved success in the development of a prepayment meter which it is now prepared to offer, for use on continuous current circuits.

This meter consists essentially of two parts—the electrical meter proper, and the mechanical prepayment mechanism, a general idea of which can be obtained from Figs. 1 and 2.

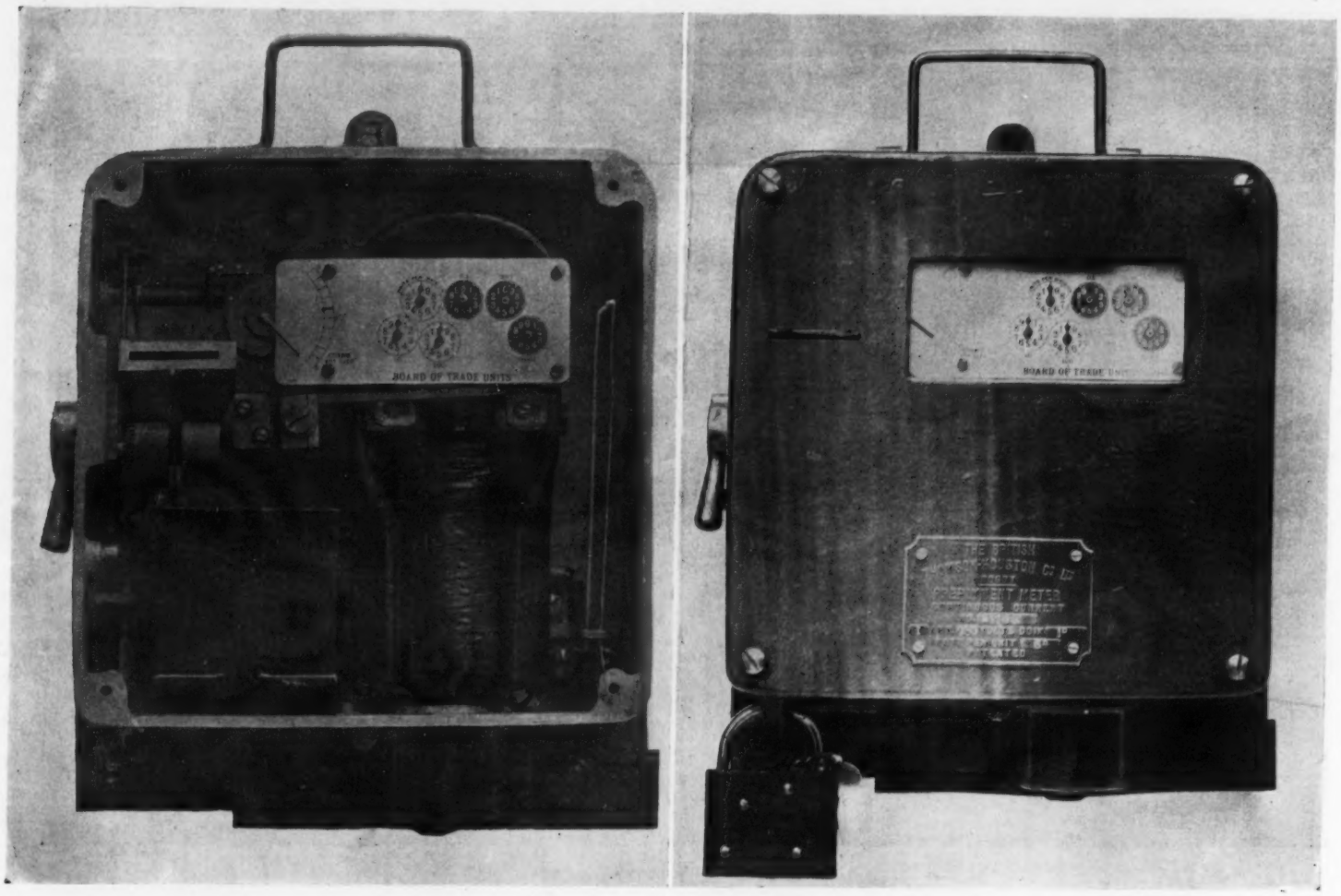
Both the meter and prepayment mechanism are contained within a strong cast aluminum dust-proof case, which is of neat appearance, and occupies a space of only 8⅜ x 10½ x 5 inches deep. It is so constructed that by the removal of the cover, which is held in place by four sealing screws, easy access to all parts of the meter and mechanism is obtained. A window is fitted to the cover, through which both the meter dial and coin indicator are visible. The meter dial registers the total number of units consumed and can be used as a check on the coins deposited, while the coin indicator shows the number of coins still to the credit of the consumer. The terminal box is situated at the bottom of the meter, and has a separate cover, held in place by a small cap covering the commutator, brush gear, and jewel screw, the arrangement being such that they can be sealed independently from the other parts of the meter. A till capable of containing 120 coins—pennies in England—is provided to hold the money deposited in the meter, which may be removed by opening the door at the bottom of the meter. This door can be secured either by a seal or padlock as desired.

The switch is of the single-pole, quick-break, knife-blade type. It is designed to open circuits carrying current up to the amount of the maximum overload allowable for the largest meter to which the device is used. The closing and retaining mechanism of the switch is positive in its action and both strong and simple in construction.

To operate the meter, a coin of the correct denomination is put into the slot provided, and the handle at the left hand side of the meter turned to its full up position, and then returned to its down position. This movement closes the switch and moves the coin indicator hand one division. Successive coins to the number of ten may be put into the meter at one time. At each insertion the indicator hand moves forward one division, and as the consumer uses the current, this hand will gradually travel back to zero, on reaching which the switch opens automatically. Additional coins can be inserted at any time previous to the consumption of the last coin, and so long as the indicator shows there is a coin or fraction of a coin to the credit of the customer the switch will not be opened. Hence by always inserting a coin before the indicator reaches zero, the light will never be switched off.

A prepayment meter must be constructed in such a way as to render cheating impossible, as should it be possible to tamper with the instrument in any way it is evident that it would be worse than useless. In view of this fact, the B.T.H. prepayment meter is made proof against any attempt to obtain current by unfair means.

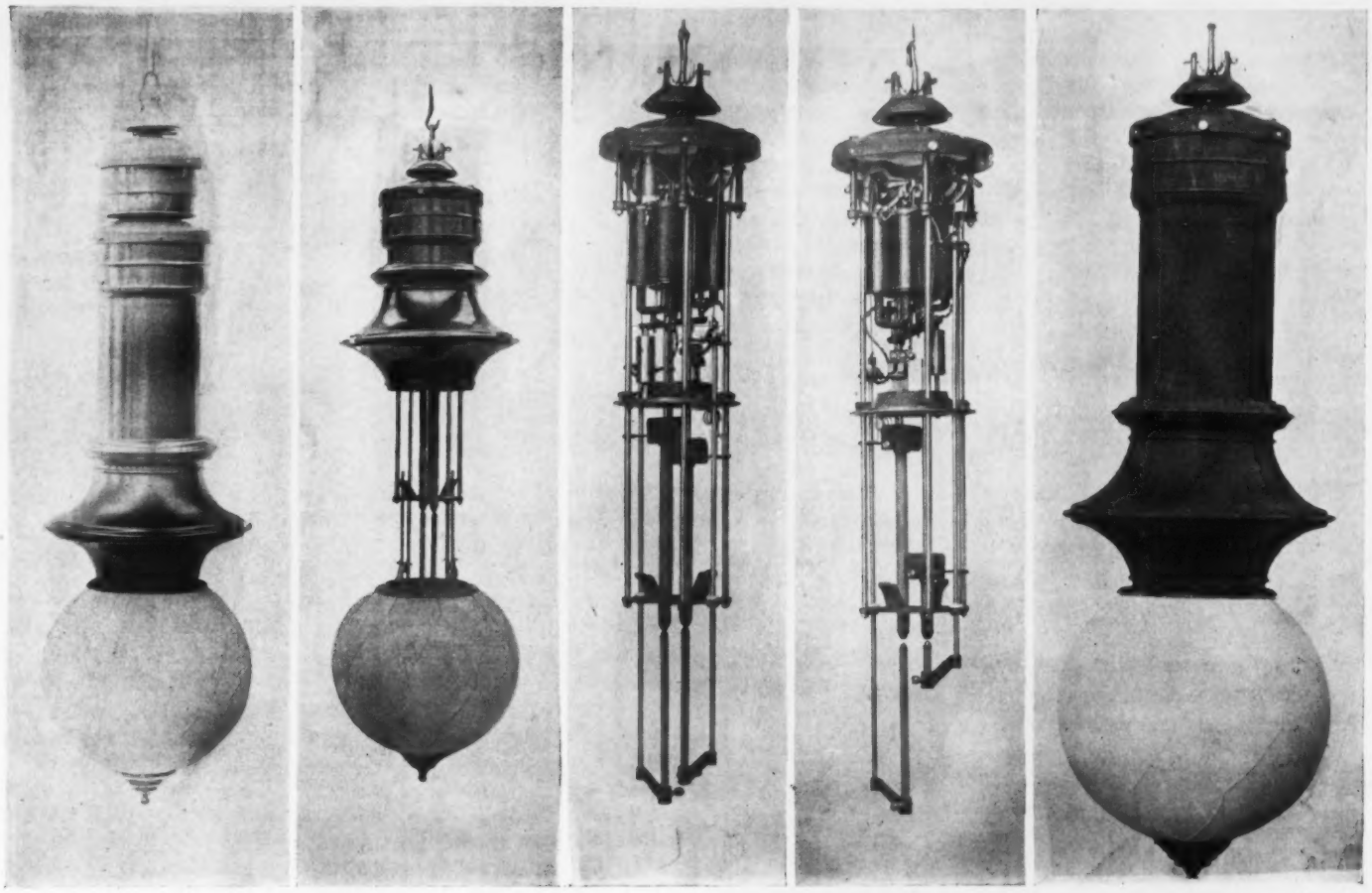
These prepayment meters are manufactured in 2, 3 and 5 ampere sizes for any required voltage, and may be operated with one penny, sixpenny or one shilling coins as desired. The rate of payment chosen can be easily changed at any later date without having to recalibrate the meter. Special care has been taken to use only the best insulating material possible. This enables the meters to be subjected to an insulation test of 1,000 volts alternating.



Figs. 1 and 2.—Continuous-Current Prepayment Meter.

Open Arc Lamps in England.

Open arc lamps still appear to enjoy a vogue abroad, and new ones are still introduced there. The British Thomson-Houston Co., Ltd., has designed, and is now manufacturing at its Rugby Works, a 10-amp., open arc, continuous-current focusing lamp. The brake wheel and feeding mechanism are of novel design. The wheel is made on the toggle principle and is very positive in its action, while friction losses are kept at a very low figure. The casing, made of solid copper, with a black oxidized finish, is constructed in two parts which slide over one another. It is supported at the top on bayonet catches, and by removing one thumb screw the upper portion can be lowered, exposing the entire mechanism for inspection or minor repairs. For trimming, the lower portion is raised, and the lamp can be trimmed by lowering the globe only 9 inches.



FIGS. 1, 2, 3, 4 AND 5.—ENGLISH OPEN ARC LAMPS.

When operating two or more lamps in series, it is necessary to have some means of adjustment in order to keep them burning with equal arc voltage. In the B.T.H. lamp this adjustment is made by shunting the series magnets with a high-resistance adjustable coil. The adjustment can be made without turning off the lamp, and much closer regulation can be secured than with a mechanical adjustment.

All parts of the lamp are made by machinery and are entirely interchangeable. No fitting is done when the lamp is assembled, and parts are designed to work together, without being so accurately fitted that their operation would be affected by the dust and dirt which always work into the parts of an arc lamp.

The lamp is so insulated that, when the casing is on, no external part is in connection with the circuit. All the interior insulation is of mica or lava, and the insulation of each lamp is tested at 1,500 volts alternating current applied for 30 seconds. The lamp has a self-contained automatic cutout, and is supplied with or without substitutional resistance as required. External line resistances are used depending upon the line voltage and the number of lamps in series. These line resistances can be supplied for mounting either on a wall or inside of the pole base, and can be made weatherproof when required. The lamp, plain, without substitutional resistance, and with globe in place, measures 51 inches in length, and weighs with globe and casing 53¼ pounds.

An Automatic Mailing Machine.

To take stacks of newspapers, magazines, catalogues or periodicals as they come from the printing press, and to fold, wrap, seal and address them individually is the office of the Agnew auto-mailing machine illustrated herewith. All this is accomplished at the rate

FIG. 1.—MAILING MACHINE.

of from three to five thousand an hour, obviously several times faster than it could be done by hand. In fact, it is claimed that one

machine will replace twelve persons, and accomplish the work with greater neatness and less liability to errors, and with less skilled attendance, one man being all that is required.

The operator standing on the side of the machine shown in Fig. 1 works in front of the elevator or conveyor, refilling the shelves as fast as they are emptied, with bunches of the papers or magazines just as they are taken from the press. The construction of the elevator is clearly shown in the cut. It consists of two sets of moving shelves carried, perpendicularly to their direction of travel, by endless chains and arranged to run at the same speed, but in opposite rotation, so that contiguous shelves register with one another. Its action is intermittent, and under electrical control, which maintains the top of the pile at a fixed height. At each cycle of the machine little pneumatic suckers come down on the uppermost paper and, with a combined lifting and pulling movement, start it far enough into the machine to be taken along by a horizontal belt conveyor. Simultaneously at the opposite side of the machine wrapping paper drawn from a continuous roll is introduced under the periodical and cut off the required length.

When the paper and its wrapper have reached a definite position

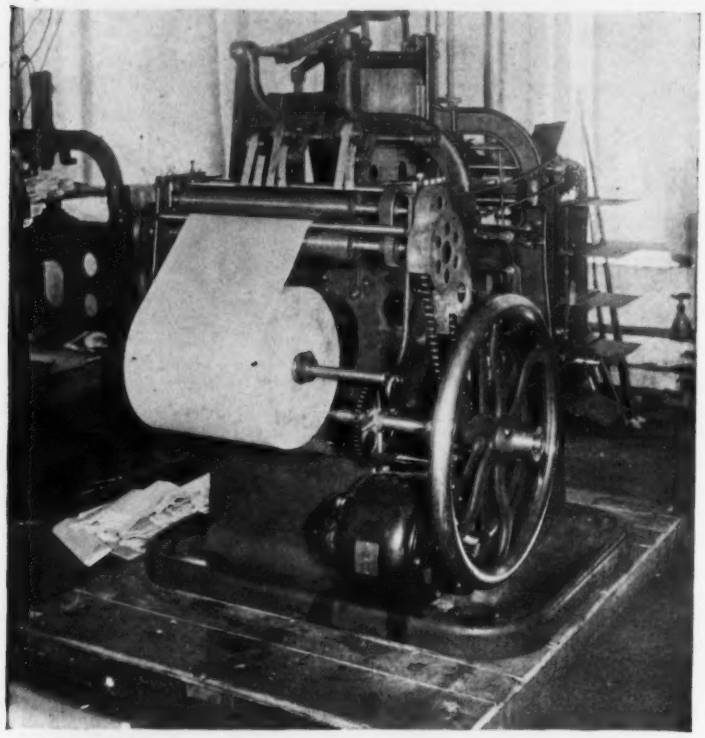


FIG. 2.—MAILING MACHINE.

a vertical blade descends, creasing them through the middle and carrying them down between a set of steel rolls. The vertical blade then returns to its upper position and a horizontal blade folds them again and carries them to a basket or receiver. The wrapper is not entirely under the paper when folded with it, consequently only part of it goes into the inside with the operation of folding. It is sufficient, however, to prevent the wrapper from sliding off the paper later on, and the extra amount projecting on the outside forms the flap. This is gummed by a roller covered with a solution of dextrine, and is pressed down by another roller as the package passes out of the machine. On the shelf at the side of the machine just before being discharged it pauses long enough to receive an impression through a stencil, giving it its individual address.

The perforated stencils for the addressing are arranged to replace one another successively at each cycle of operations. These may be previously assorted by towns or States, thus eliminating the necessity of distributing the mail afterward. For instance, all of a certain group may be run through at a time and discharged into one mail bag, another being in readiness to be moved up to receive those belonging to the next group and so on.

One motor mounted against the side of the machine at the rear, as shown in Fig. 2, provides the power with one reduction through a spur gear and pinion. It is noticeably out of the way and fortunately located where it is protected by the fly-wheel. The motor is of the Crocker-Wheeler make, of a semi-enclosed type, and of 1-hp size, which shows that the cost of running is not very great.

The machine is positively driven at all points by chains or gear connections, so that there is no chance for slipping and causing a loss of co-operation between the different parts. Furthermore, there is an electrical device to open the motor circuit automatically and stop the machine if any interruption in the regular operation occurs, such for example as when a paper fails to feed, or a wrapper is not in place, or when the stack of stencils is exhausted.

The entire machine occupies a floor space of about 4 x 5 ft., has an overall height of 76 in. and weighs about 2,000 pounds when equipped with a Crocker-Wheeler motor, as shown.

Latest Types of "C & C" Dynamos and Motors.

After over two years spent in preliminary work, the C & C Electric Co., of New York, with works at Garwood, N. J., is placing on the market its new line of "type 'S'" direct-current dynamos and motors. The C & C Co., as most of our readers doubtless know, is a pioneer manufacturer of direct-current motors, its experience

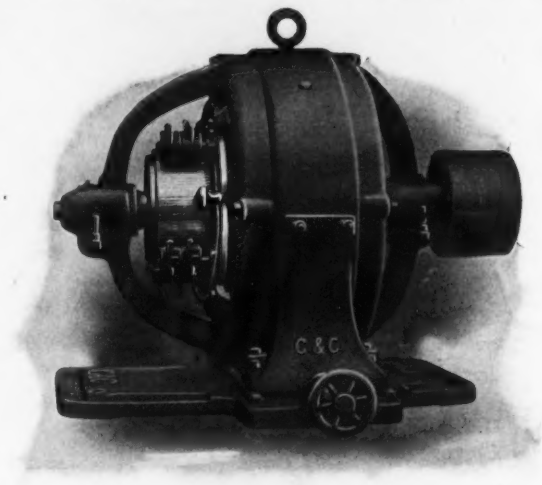


FIG. 1.—OPEN TYPE FLOOR PATTERN.

covering a period of over 16 years, during which time it has been exclusively engaged in the manufacture of dynamos and motors for industrial purposes. Its aim in designing the type "S" machine has been to produce a motor or a dynamo of artistic and attractive design, pleasing appearance, minimum weight, compact and symmetrical, and adaptable to almost any class of service. It also aimed at a machine which would be of the highest efficiency, and would withstand unusually heavy overloads without sparking, and with a much lower temperature rise than has heretofore been the case. The apparatus is built in all the standard sizes from 2 to 30 hp inclusive, for

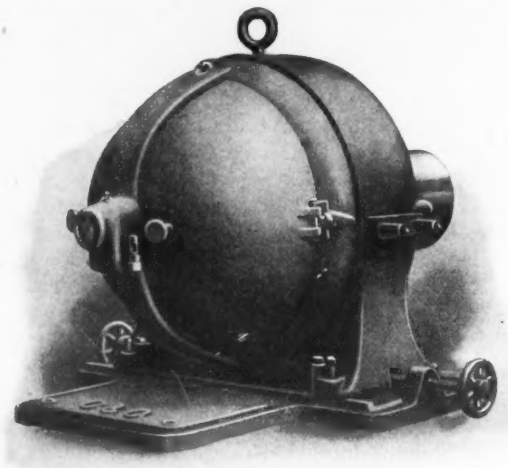


FIG. 2.—ENCLOSED TYPE FLOOR PATTERN.

slow and moderate speed, and expects before long to have ready an entire line from ¾ to 75 hp inclusive.

The machines are made in the open, semi-enclosed and entirely enclosed types. The open-type, floor-pattern machine is illustrated in Fig. 1; the enclosed-type, floor-pattern machine in Fig. 2. Both these illustrations give a good idea of the symmetrical and pleasing

appearance of the machine. The machines are furnished in the floor, ceiling or wall (see Fig. 3) horizontal patterns and in the vertical pattern. The motors are well adapted for mounting upon machine tools or machines of almost any description, for direct connection or chain drive. The machines are all of the four-pole type. The magnet frames are of soft homogeneous cast-steel, as are the brackets or feet, and the pole-pieces, which are cast as part of the magnet frame. The pole-tips or shoes are of the same material, and secured

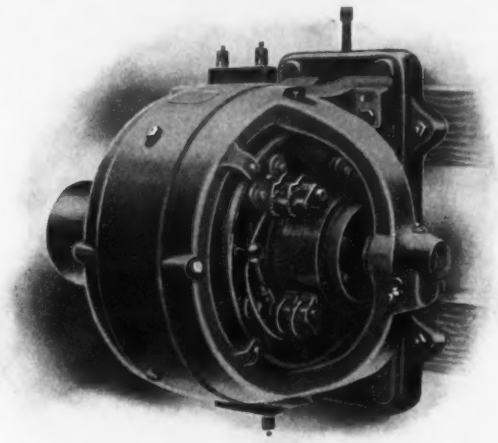


FIG. 3.—VERTICAL PATTERN.

to the pole-pieces by means of external bolts. The bearing-brackets are of cast-iron and carry self-oiling and self-aligning bearings of generous dimensions. A frame-ring is cast as part of each of the brackets, and this ring carries lugs between which the cast-iron brush-ring is supported. The brush-holders are of the well-known "C & C" "reaction" type and are secured to brass pins carried by the insulated brush-rings. This form of support of the brush rigging assures absolute stability and non-vibration of the brushes. The field coils are wound on metal bobbins of novel construction and are readily removable. The armature is of the hollow drum type. The insulated laminæ forming the core have three openings punched therein around the shaft hole for ventilating purposes, and a spacing spider is placed in the centre of the core for the purpose of forming air ducts connecting with the three channels adjacent to the shaft. Form-wound coils are laid in the armature slots and are retained therein by means of hard wood wedges driven between notches in the teeth of the armature core; consequently no band wires are used for retaining the coils in position. The commutator is of unusually large diameter and face, and is composed of hard drawn copper bars insulated with mica, assembled in a heavy cast-iron shell, mounted on the armature spider.

The C & C Company states that after a continuous run of 24 hours at full load, no part of the machine will show a temperature rise of over 30° C. by thermometer. It also makes other unusual guarantees. This unusually low temperature increase is accounted for by the novel construction of the armature. The armature laminæ spacers, back-plate and end-plate, as well as the commutator itself, are so designed that their several parts radiating from the shaft act as the vanes of a fan, and when the armature is in motion a powerful draught is created. The cool air is taken in through the commutator shell, and part of it is forced through the ventilating ducts of the armature up against the pole-pieces and fields; the remainder through the back of the armature; thus cooling the whole machine. The construction of the armature, as well as all the component parts of the "type 'S'" machine, are well shown in Fig. 4.

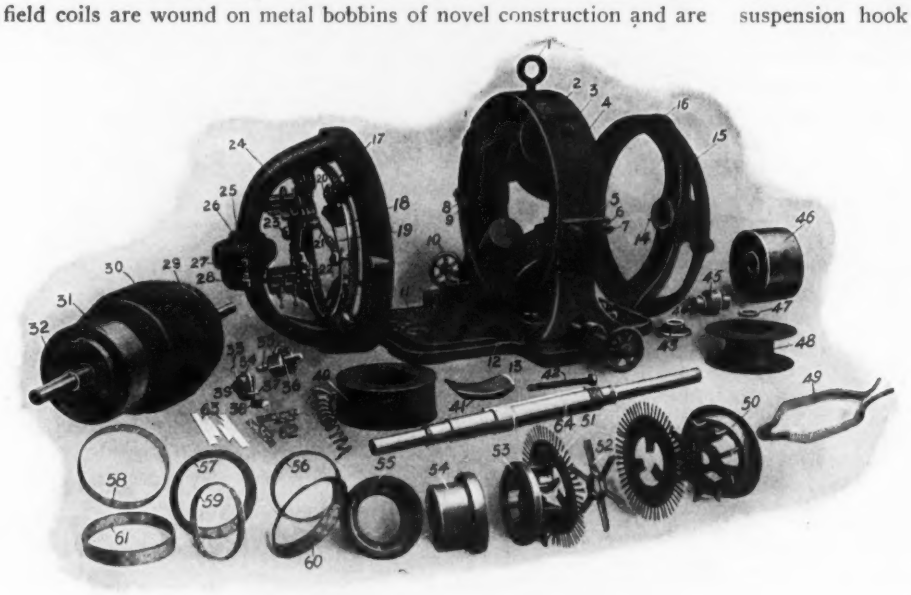


FIG. 4.—COMPONENT PARTS OF MACHINE.

"Core" Transformers.

A new line of transformers has recently been manufactured and put upon the market by Messrs. Hornberger and Irwin, who have been identified with the development of alternating-current apparatus from the outset, and who have organized the Crawfordsville Electric Company, of Crawfordsville, Ind., for the purpose of producing apparatus of a standard character in this field of work. Based upon their familiarity with the subject and their experience, they have selected the core type of transformer for manufacture in preference to the shell type, and while admitting that in core type transformers, as ordinarily known, sundry disadvantages appear, they claim that they have overcome the points of objection as to length of core and excessive temperature. In all but the smaller sizes they employ multi-coil construction.

The Crawfordsville Electric Company, as just intimated, builds transformers in the smaller and intermediate sizes, such as are generally used by central stations, but it also builds those of the larger size and heaviest duty, and hence has found it advisable to provide a separate case design for each of the different classes. Their design for sizes up to 15 kw consists of a simple cast-iron case arranged for the use of oil and equipped with steel hangers in the usual manner. For convenience in hanging the smaller sizes they use the well-known suspension hook devised by one of the members of the company.

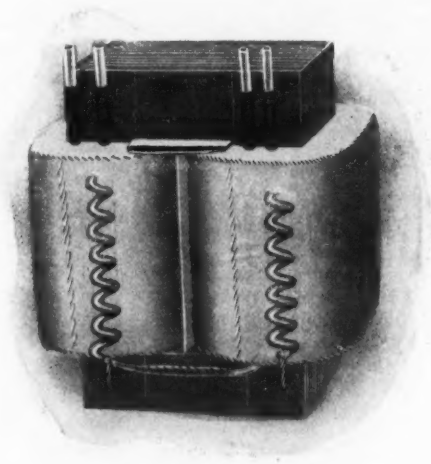


FIG. 1.—"CORE" TRANSFORMER.

The cable terminals are brought out from the case through heavy porcelain bushings securely cemented in place with a compound which prevents effectually the entrance of rain or moisture. All cable connections are made permanently and no connecting block is used inside the case.

For sizes from 20 kw up to 100 kw, inclusive, the case is made with a cast-iron base and cover and with a body of substantial sheet steel. While the sheet-steel case is superior to a cast case and is more expensive to build, the weight is greatly reduced. As a comparison, it may be mentioned that the 50-kw Crawfordsville case complete weighs only 350 pounds, whereas the cast-iron case of a well-known type of the same size weighs over 800 pounds.

For sizes larger than 100 kw the case design is made for foundation support only, on account of the heavy weight, and is so arranged

that it can be adjusted to either oil, air-blast or water circulation. The construction is massive, in keeping with the heavy duty for which it has been designed, such as street railway work or long-distance high-voltage performance. The transformers of this magnitude are designed for any frequency from 25 upwards, for any voltage, and for single or polyphase circuits. In sizes of this type

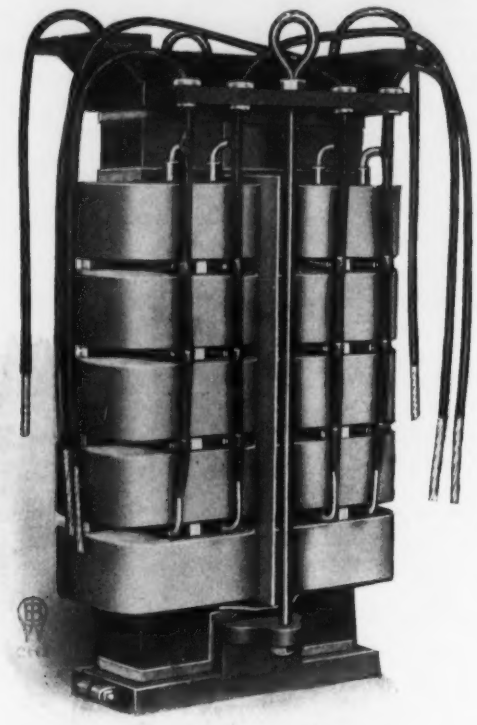


FIG. 2.—MULTI-COIL TRANSFORMER.

the multi-coil construction is used, the complete transformer being made up of many coils, each having the required number of ratio turns within itself, and all coils being then joined in multiple to the terminals; so that a possible disablement of one coil does not mean that the entire transformer must be replaced or the terminal voltage lowered.

In these "H. I." transformers, as they are known, the cross-section of copper allowed is liberal, and the copper used is electrolytic.

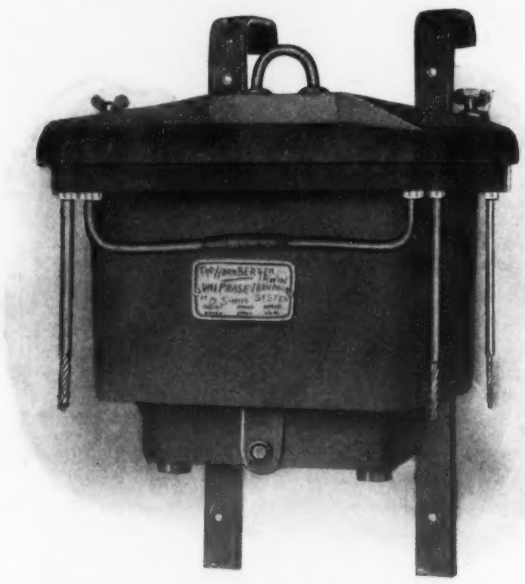


FIG. 3.—TRANSFORMER COMPLETE.

Owing to the multi-coil construction used, cross connection of coils is unnecessary in order to maintain the equal voltage on each side of the neutral wire for three-wire distribution. Ample allowance of copper has also been provided for the increased amount of current required in the operation of inductive apparatus of low power factor. Special attention has been given also to questions of insulation, and mica insulation is used throughout in the construction of the coils, reducing to a minimum the liability or tendency to break down. An improved porcelain fuse box is furnished with broad electrical contacts and liberal copper parts, as well as a long fuse which will break the circuit in every case without injury, ample vent being provided for the escape of gases. The use of oil is recommended, especially in the larger sizes, but the company's guarantee requires that the oil used in the transformers shall be furnished by the company itself. All transformers are tested before shipment under a break-down voltage of 10,000 volts between primary and secondary windings and between the windings and the core. With the multi-coil core type construction and the low densities secured, together with the special steel employed, "ageing" is regarded as impossible, when the apparatus is operated in accordance with its design and purpose; but the company stands ready to replace any transformer showing an appreciable increase of core losses.

Englarging the Field for Unwired Clusters.

The "wireless" clusters made by the Benjamin Electric Manufacturing Company of Chicago are becoming such a staple electrical article that it will be of general interest to state that the company has recently brought out a shade holder which makes it possible to

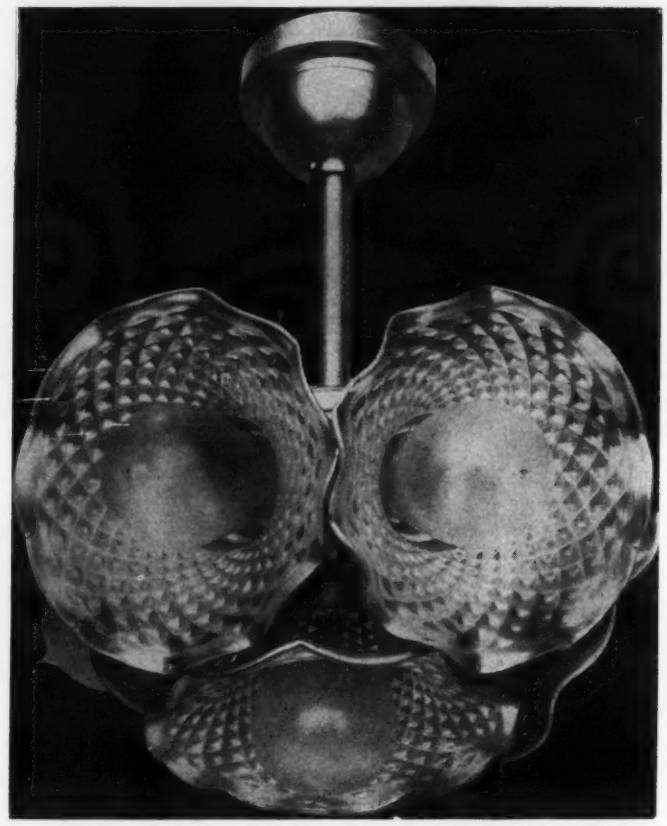


FIG. 1.—CLUSTER WITH INDIVIDUAL SHADES.

place an individual shade on each lamp in a cluster, as shown in Fig. 1. This shade holder fits under the lamp receptacle bushing of any Benjamin wireless cluster. A fixture with a cluster of shaded

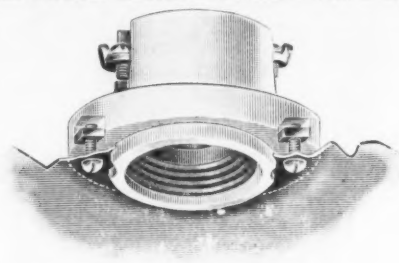


FIG. 2.—RECEPTACLE FOR LARGE GROUPS.

lamps of this kind is pleasing in its simplicity and will materially add to the possible uses of the wireless clusters.

In Fig. 2 is shown a new lamp receptacle, by which the company is enabled to put together easily large clusters of any desired number of lights.

The Reeves Vertical Cross-compound Engine.

Any improvements that add to economy, efficiency and convenient handling of a steam engine, particularly when of a nature that lessens personal attention and assures constant operation, are always of interest, and below are briefly described some of these features as embodied in the Reeves engines.

The design of these engines permits of the development of great power within very small floor space and provides for easy access and adjustment of all parts. In the engine shown in Fig. 1 the cylinder dimensions are 10½ in. and 24 in. x 14 in. stroke; the shaft is 6½ in. in diameter and is provided with three bearings, the outside ones being 11 in. and center one 10 in. long, all the parts so proportioned as to assure a perfectly balanced machine.

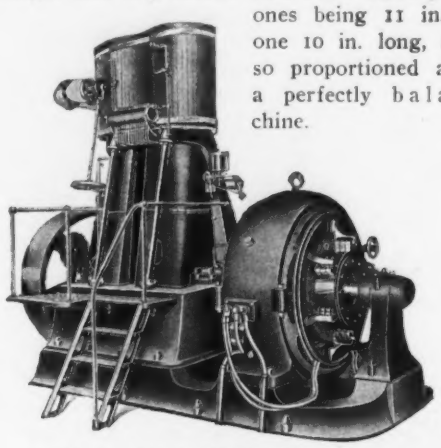


FIG. 1.—CROSS-COMPOUND ENGINE.

In the cross-section, Fig. 2, the high-pressure piston is about to start on its downward stroke, and the low pressure on its upward stroke. The admission valve is moving upward, admitting steam on the top of the high-pressure piston and across through the connecting port, *B*, and around the head of the main valve. At the same time the main or center valve is moving downward, admitting steam under the low-pressure piston. This is the exhaust steam from the previous stroke of the high-pressure piston, which passes through the port, *B*, around the neck of the main valve and through port *C* into the bottom of the low-pressure cylinder.

When the pistons have moved about three-eighths of their stroke the admission port has been opened and the admission valve returned to point of cut-off. The main or center valve is now moving upward and finally closes port *C*. At this point compression commences in the high-pressure cylinder and continues until the main valve opens the port, *C*, again; meanwhile the main valve closed the upper port and compression took place in the low-pressure cylinder.

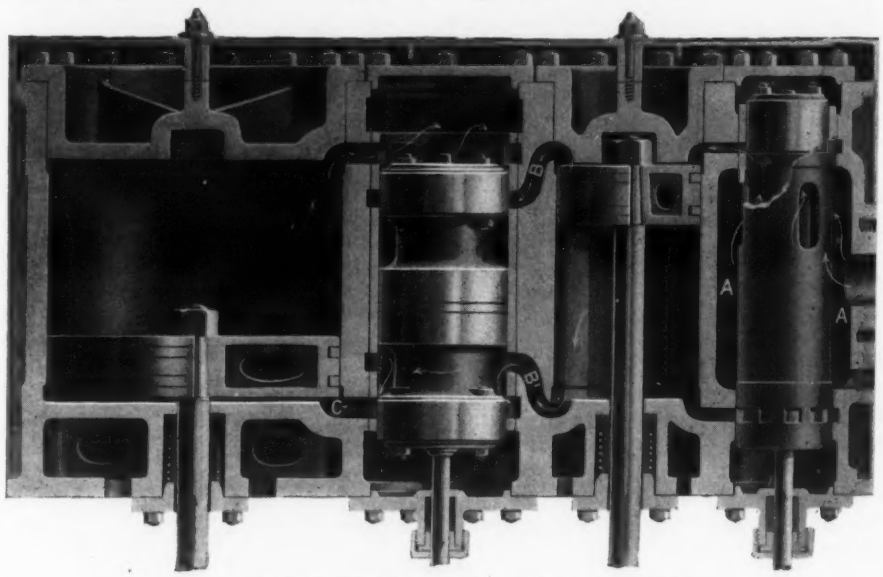


FIG. 2.—CROSS-SECTIONAL VIEW OF ENGINE CYLINDERS.

The steam distribution gives practically an equal division of work in the high and low-pressure cylinders and there being no receiver employed, losses from free expansion and condensation are obviated. The engines are so designed that either cylinder can be used, independently of the other, should necessity require.

The chamber, *A*, around the sleeve in which the admission valve works, acts as a separator and is drained, as can be seen, at the extreme lower end. The sleeve receives the direct impact of the steam instead of the valve; the latter is absolutely balanced, as all its exposed surfaces are under constant uniform pressure. Each of the three openings in the sleeve are larger than the steam pipe, and the steam is, therefore, not wire-drawn in passing to the cavity inside the sleeve.

The cubical capacity of chamber *A*, together with space inside of sleeve, is greater than the amount of steam the high-pressure cylinder can take, up to three-fourths cut-off; as a result, the cards show remarkable steam lines, the actual difference between the initial cylinder pressure and pipe line pressure being extremely small. The space formed by the separator acts as a bank or storage from which the engine draws its supply of steam.

The separator being close to the high-pressure cylinder, acts also to a degree as a superheater; thus instead, as in other separators, being a source of loss, it is here a direct gain, it is evident that any heat it may lose must be taken up by the cylinder. There is no repassing of steam over the same surfaces, which is, in itself, a guarantee of economy. The low cylinder heads are cast integral with the cylinders, which reduces the number of joints to keep tight.

The piston valves employed assure practically constant economy, as they can be easily adjusted (each end independently of the other), and made steam tight without removing them from their seats, and while steam is on the engine.

Referring to the governor, the holes for the shaft and governor pin are bored at the same setting, thereby assuring perfect alignment; then a hard cast-iron bushing, which has been carefully reamed and ground, is pressed into the cavity that is to carry the pin. Into this bushing is introduced a carefully finished gun metal sleeve, constructed with connected lubricating grooves on the inside and outside, around and lengthwise, and by means of which the lubricant, which is supplied by force feed grease cups, is carried to all bearing surfaces.

The governor is attached to the wheel by inserting the pin through the gun metal sleeve. The shoulder on the bar will face the finished surface on the back of the wheel, and the end of the pin will come flush with the face of the sleeve on the front and be held in place by the cap, shown in cut. Referring to the pawl on the cap, and the teeth that are cut into the rim of the sleeve, it will be seen that when the cap is in place it must move with the pin since it is securely held by a dowel and stud bolt.

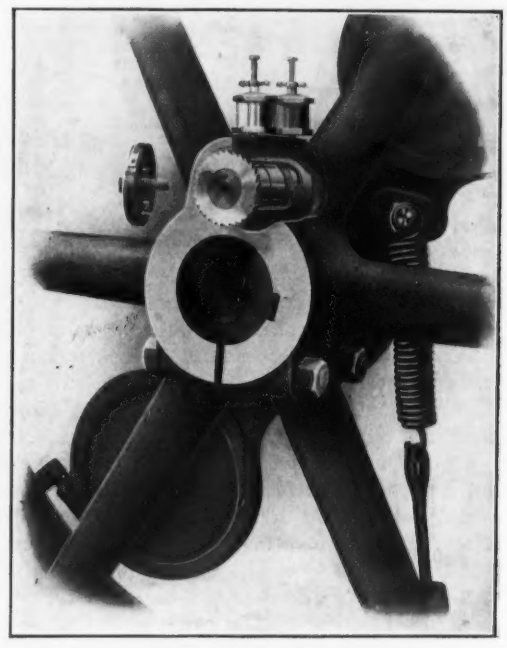


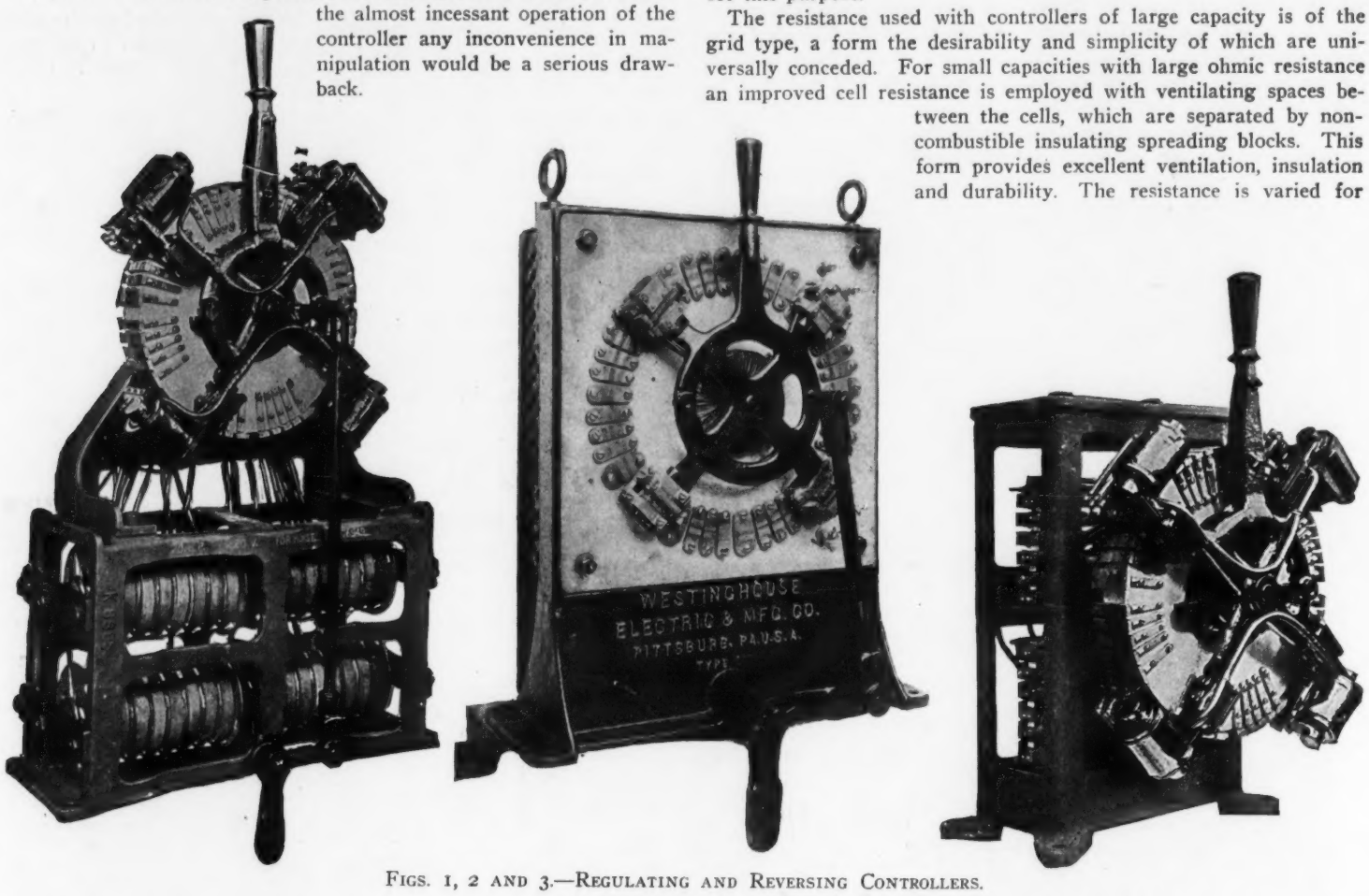
FIG. 3.—THE GOVERNOR.

When the governor arm moves away from the stop on the rim of the wheel—as it is sure to do when the engine is started or whenever there is any material change in load—the pawl on the cap will pick up a tooth and turn the sleeve a short distance (always in the same direction); when the arm moves back another tooth will be engaged and the operation repeated, thereby presenting continuously to the

pin a freshly lubricated and practically new bearing surface. This insures constant lubrication and practically perfect continuous regulation. Any wear that may occur takes place on the revolving sleeve, and this being interchangeable can be replaced, when necessary, in a very few minutes.

Regulating and Reversing Controllers.

Controllers for motors used upon cranes and in other places where frequent stops and reversals are necessary must have unusual sturdiness, in order to withstand the strain and wear of constant motion. They must also be simple and positive in action in order to give perfect control of the motor, both in speed and direction of rotation, and with the fewest possible movements of the handle, for with the almost incessant operation of the controller any inconvenience in manipulation would be a serious drawback.



FIGS. 1, 2 AND 3.—REGULATING AND REVERSING CONTROLLERS.

To meet the peculiar requirements of such service, controllers possessing the desired features have been designed. One style of such a device, the commutator type, as made by Westinghouse Electric and Manufacturing Company for use with direct-current series, shunt and compound motors, is shown in the accompanying illustrations. In form and construction it is unlike any other controller and its design enables the manufacturers to give special prominence to the qualities most desirable in an appliance of this kind.

For convenience in installation, it is made in two forms. In one type the controlling mechanism is mounted on the side of the frame containing the resistance, and in another it is mounted above the resistance as shown. The space available for installing controllers for motors used with cranes and other machinery is usually greatly restricted, and this provision for adapting the device to the place in which it is to be used is of corresponding value.

The controlling mechanism is mounted upon a circular slab or base of insulating material, which provides high insulation between adjacent contacts and between the contacts and ground. Throughout the entire controller, ample provision for insulation is made.

Both the contact and finger tips can be easily removed and renewed without disturbing the connections. The contacts are arranged in parallel rows along the periphery of the disc, the relative position of the contacts and the finger tips being the same as that of the brushes and commutator in a generator or motor—a form which has been found more desirable than any other for this particular service. The same contacts are used for application of the current in either direction, thus lessening the number required, while an effective magnetic blow-out makes it impossible to maintain an arc and prevents burning of the contacts.

Each controller has four brush holders mounted upon a rocker arm to which the handle is attached directly, working without gears or pinions. A single movement to right or left applies or reverses the current, and the distance the handle is moved determines the motor speed by varying the amount of resistance in series with the motor armature. There are sixteen steps in each direction and a very close regulation of the speed is thus obtained.

When the controller is placed in the rear of a crane cage, it is operated by a crank and lever directly attached to the spider which carries the brushes. The second type above mentioned, with the controller mounted above the resistance, is very generally employed for this purpose.

The resistance used with controllers of large capacity is of the grid type, a form the desirability and simplicity of which are universally conceded. For small capacities with large ohmic resistance an improved cell resistance is employed with ventilating spaces between the cells, which are separated by noncombustible insulating spreading blocks. This form provides excellent ventilation, insulation and durability. The resistance is varied for the different capacities and uses of the motor which the controller governs, a different resistance being used for crane controllers where a closer regulation is required than is provided for roll tables and soaking pits, where sudden and repeated starting and reversing is the prime requisite.

The chief characteristics of this type of controller are its simplicity, strength, durability, flexibility of application, and ease of manipulation. Any mechanic can care for it, and keep it in order, the cleaning, oiling and renewal of contacts when necessary, being all that is required. All parts are exposed to view, and connections are easily made.

Controllers of the commutator type are made regularly in capacities of from 3 to 75 hp, but are furnished especially of any capacity desired. For less than 10 hp, the Westinghouse Company makes a face plate type of controller which contains many of the main features of the device described. It is small and compact; has contacts and finger tips which are easily renewed without disturbing the connections; has a powerful magnetic blow-out, and in principle and manipulation is the same as the commutator type. The resistance used is especially designed for the purpose and is particularly effective and durable, withstanding an extraordinary amount of heat without impairing its efficiency.

The three types illustrated afford a choice of a regulating and reversing controller suitable for any service within the range of capacity named.

Flush Receptacle and Plug.

A flush receptacle and plug is ordinarily used as a means of connection between an electric circuit and some portable device requiring current. It is obvious that the simpler the means of making this connection between the plug, which is attached to the device by a flexible conductor, and receptacle, which is stationary and fastened in the wall—the better the result. In the usual receptacle and plug, one hand is required to open the face plate and the other to insert the

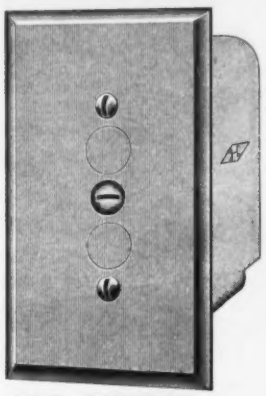


FIG. 1.—FACE PLATE.

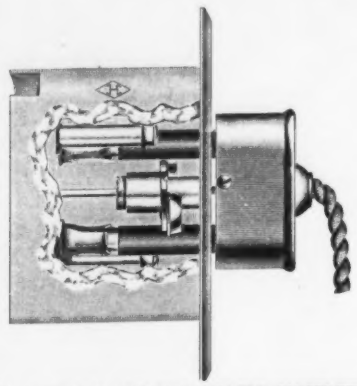


FIG. 3.—PLUG AND RECEPTACLE COMPLETE.

plug. In the "Diamond H" receptacle and plug, the shutter for the opening in the face plate is automatically operated by the plug itself —one hand, only, being required.

These receptacles are made in gangs of any number, or are put in gangs with the "Diamond H" push button or rotary flush switches, and will fit the usual wall appliances designed for these

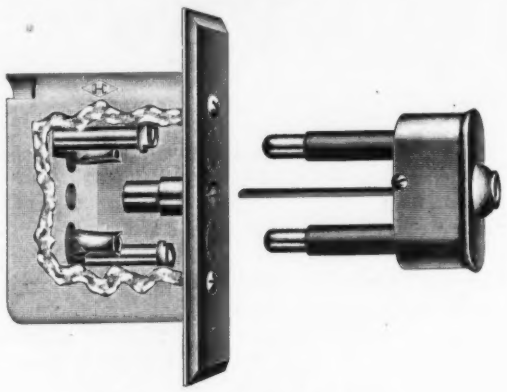


FIG. 2.—RECEPTACLE AND PLUG.

switches. Fig. 1 is a cut of the face plate, plug removed; Fig. 2 shows the plug in a position for entering the face plate; Fig. 3 shows the plug and receptacle complete.

The device is manufactured by The Hart Manufacturing Company, Hartford, Conn., manufacturers of switches bearing the same designation.

Variable Speed Too Drive Motors.

In order to meet the demand for variable speed in motors for tool driving, the Commercial Electric Company of Indianapolis, Ind., have brought out a line of Commercial variable speed motors specially designed to meet the problems connected with the subject. In these machines herewith illustrated (Fig. 1), the variation of speed is accomplished by means of a double commutator armature, having two different windings; but each winding is of the same size conductor or of the same ampere capacity. A range in speed is secured of four to one, in twelve uniformly graded steps without overlapping. A speed controller is furnished for making the necessary combination of these armature windings and for varying the field strength to secure the intermediate steps between the armature combinations. These controllers are simple and compact and the changes from minimum to maximum speed are easily and quickly effected. The controllers are made reversible. Included in the controller is the rotary starting and reversing switch, by means of which the motor is started, stopped and reversed, while the speed control is set at any desired point. The speed controller and starting switch are combined into one piece of apparatus and enclosed in a neat compact case which can be placed at any desired point on a driven tool, or which can be mounted on a stand con-

FIG. 1.—VARIABLE-SPEED MOTOR.

FIG. 2.—CONTROLLER.

veniently located by the side of the tool. This controller may contain a main switch or not, as may be desired. Fig. 2 shows a universal interlocking controller and stand. Fig. 3 illustrates the motor equipment in connection with a standard machine lathe. The litera-

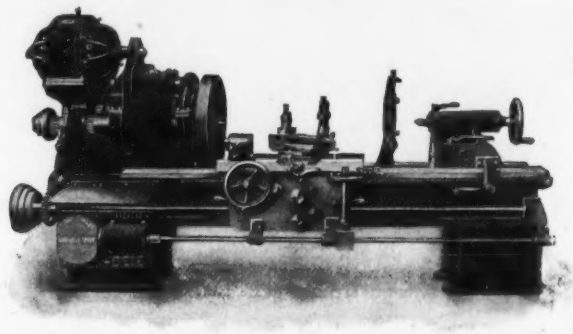


FIG. 3.—MOTOR-DRIVEN LATHE.

ture of the company gives further data, including some interesting curves of performance. The motors range from 2 up to 20 hp, weighing 500 pounds in the smaller of these two sizes, and 2,475 pounds in the larger.

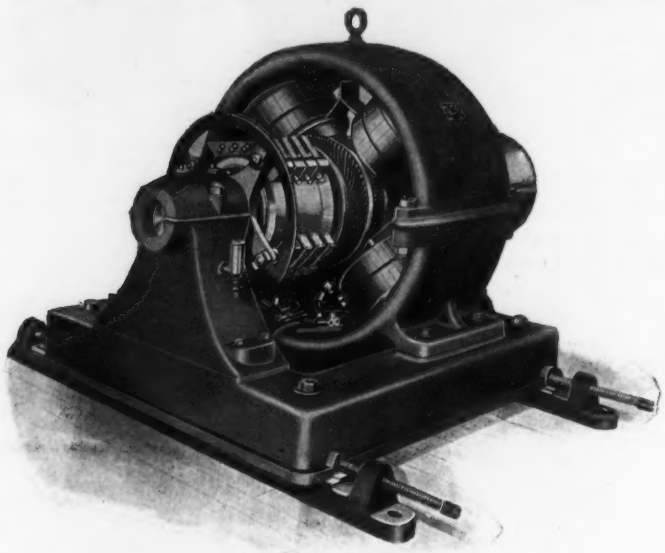
"Ideal" Multipolar Generators.

The cut herewith shows the new line of generators being manufactured by The Ideal Electric and Manufacturing Company, Mansfield, Ohio, and is known as its "Type D," ranging in capacity from 25 to 150 kw. They are four pole up to and including 40 kw, slow speed; the larger machines being of six pole design. The magnet frame is of soft cast iron divided horizontally in all sizes and with forged steel magnet poles of circular cross section cast welded into the frame so as to insure an absolutely perfect magnetic joint. These poles are provided with cast-iron shoes which protect and support the field windings and embody the special features of this construction in reducing the density of the magnetic flux where it enters the armature, and permitting the use of a comparatively large air gap.

The armature is of the iron-clad type having a laminated core of the best quality of sheet steel of very thin gauge. Ventilating ducts are provided at right angles with the shaft and transversely through the core, insuring perfect ventilation. In the smaller sizes the core discs are mounted directly on the shaft and securely keyed thereto; while the larger sizes are provided with armature spiders so devised that the armatures can be arranged for mounting directly on the extended crank shaft of the engine for direct-connected service. Ribbed flanges are mounted on the outer edges of the core discs which ventilate the outer surface of the armature core and the windings at the bend of the coil. The windings consist of form-wound coils made of flat copper strip thoroughly insulated with horn fibre linen tape, dipped in the best quality of insulating

varnish and thoroughly baked. Surface bands are used to retain the coils in the slots.

The commutator segments are well proportioned, being of sufficient length and depth to allow ample margin for wear. The flanges are of cast iron, insulated from the segments with solid V rings. The mica segments are of the best grade of pure, soft mica and the mechanical construction of the commutator is very rigid. Copper-coated composition carbon-graphite brushes are also used, clamped directly on the face of the holders. The holders are of heavy brass construction amply large to carry all current required without heating. The holders are of such a type that the brushes operate without vibration and the machines run cool and sparkless. The brush holder stems to which the holders are fastened are insulated from the quadrant and firmly secured in place to prevent



MULTIPOLAR GENERATOR.

them from working loose. The brush surface never exceeds 30 amperes per square inch of carbon contact.

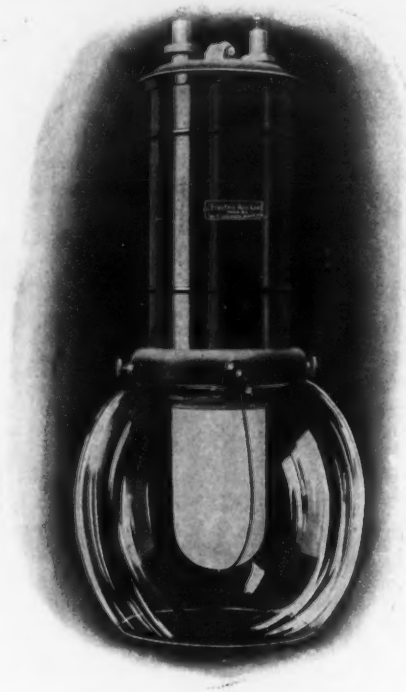
The generators are designed to operate at their full rated capacities without a rise in temperature to exceed 30° above the surrounding air in either the armature or field winding, and 35° C. rise in the commutator. They are built to operate at an overload of 25 per cent. for two hours, and to withstand an overload of 50 per cent. for two to three minutes without injurious heating or sparking. The machines are thoroughly tested before leaving the works and guaranteed against defective workmanship or material.

Series Enclosed Arc Lamps.

A series enclosed arc lamp for use on 9.6 ampere circuits, which has now been in successful use for over six years, is now being made in quantities for the general market by Mr. W. F. Warner, of Muncie, Ind., its inventor and designer. During the past nine months, the lamp has been introduced in a number of cities, and has found favor as a lamp made for electric light men by one of themselves. Mr. Warner has had a number of years of experience in the manufacture of electrical instruments, and for over twelve years has had active control of electric light plants. Throughout this period he has been impressed with the need for such a lamp as he has worked out and introduced. The lamp is a very radical departure from the ordinary arc lamp construction. It is of the shunt feed type, and is purely electrical in its operation. The shunt coil does not control the feed of the carbon in the usual mechanical way, but does it electrically. Mr. Warner has therefore been able to simplify the interior of the arc lamp very much, doing away with springs, levers, cut-outs, pinions, and other familiar features.

While the lamp was designed especially for 9.6 amperes, and gives satisfactory service, operating on 50 volts at the arc, it will work equally as well, or perhaps better, on circuits of lower amperage. It is furnished for multiple work as well as series. The lamps are enclosed within a sheet copper hood, and the finish is natural copper for the hood, and aluminum finish for the top and bottom castings.

It might be well here to mention three of the features which have made the "Warner" enclosed arc lamp a success on circuits of such high amperage. In the first place he uses a globe which is considerably larger than the ones used on ordinary enclosed arc lamps, and instead of using an iron gas cap, he has made the gas cap entirely of an insulating material in one piece, which is an insulator to both heat and electricity. This cap with its globe is at a reasonable distance from the bottom of the lamp body, permitting the air to circulate around and about the globe, and the



SERIES ENCLOSED ARC LAMP.

gas cap so as to dissipate the heat without allowing it to enter the lamp body, and thereby raise the temperature of the mechanism.

The cut shows an outer globe which has some radical features. Most of the objections made to enclosed arc lamps lie in the extra time required to trim, and the many broken outer globes on account of having to remove these each time the lamp is trimmed. The Warner globe has a large opening at the bottom to allow the inner globe to be removed and the lamp trimmed without having to take the outer globe off. This saves considerable time in trimming a lamp, and many broken globes, aids very much in keeping the inner globe cool, and has thereby increased the life of the inner globe itself.

Electric Signs and Letters.

The increasing requirements in regard to safety, durability and good appearance of electric signs and letters have caused the in-

FIG. 1.—ELECTRIC SIGN.

troduction of steel in their construction. The Haller Machine Company, of Chicago, has given much thought to improving the construction of electric signs and letters, and has put on the market such

FIG. 2.—ELECTRIC SIGN.

goods. These signs are constructed of galvanized sheet steel, and although they are quite rigid and strong they are surprisingly light. The signs are decorated with embossed metal ornaments and scroll work, finished in gold leaf and colors, and are, therefore, very attractive also as day signs. The sign letters have a glossy white

enameled face, reflecting the light brilliantly, while the sides are usually bright red, and the background smalted blue or black. All parts, the letters, ornaments and background, are in one piece, and none can come loose. The metal has further the advantage that it does not shrink, warp or crack, and is incombustible, waterproof and weather-proof. The lamp sockets used have removable shells. The letters are made either in the old raised or box shape, in a novel depressed or grooved style. The latter need fewer lamps and less current, as the light from the lamp is concentrated in the grooves of the letters that show up in distinct outline and can be read at any angle without blurring.

Besides different kinds of flashers, automatic switches, etc., the above company has also put on the market Goltz's automatic dimmers, by which the lights are quickly brought from darkness to full brightness, in which they stay a while, and then turn quickly to darkness, staying dark for a while, etc. The duration of darkness

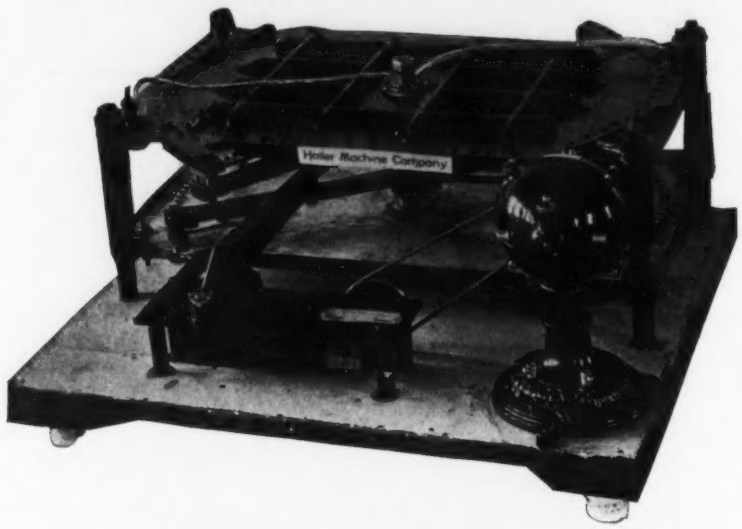


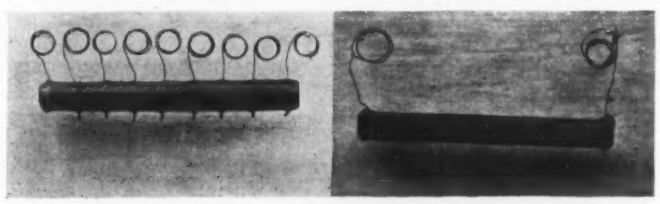
FIG. 3.—AUTOMATIC SIGN DIMMER.

and brightness can be regulated and thereby any desired saving of current made, say from one-half to two-thirds. Double dimmers operate as described above, on two parts of a sign in rotation.

Besides full background signs, the Haller Machine Company manufactures wire screen signs, roof signs and single electric letters from seven inches up to twenty-five feet in height. The small cuts herewith, Figs. 1, 2 and 3 show a raised letter sign, a grooved letter sign and a large automatic double sign dimmer.

New Resistance Unit.

Mr. H. Ward Leonard, president of the Ward Leonard Electric Company, has designed and perfected a resistance unit to meet the most advanced ideas regarding permanent high resistance. It is a porcelain tube, the thickness of a lead pencil, and only 2 in. long, with 5,000 ohms of resistance, but with only one layer of wire. The enamel covers all the resistance wire and the connection between



HIGH RESISTANCE UNITS.

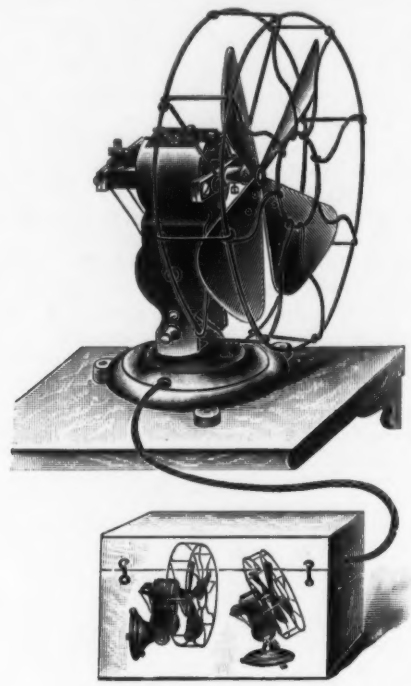
the small resistance wire and the larger terminal lead wire. The wire and joint are, therefore, hermetically sealed from the atmosphere and its corrosive action. Eleven thousand ohms can be put upon a tube 4 in. long by 7/16 in. diameter.

The cut shows a high-resistance unit tapped, giving eight equal steps of resistance. These units are especially applicable for use in constructing small rheostats, telephone resistance, etc.

Battery Fan Motor.

Many of the early battery fan motors were grotesquely inefficient, but in this line as in others, good engineering design has been brought to bear. The fan motor shown herewith, built by the Knapp Electric Novelty Company, of New York, may be cited as an illustration of improvement in this field.

This efficient, attractive and low-priced fan, taking current from portable batteries and easily moved as occasion requires, is designed for use where the street current is not available. The field is formed from steel punchings and the armature is drum-type with six teeth.



BATTERY FAN MOTOR.

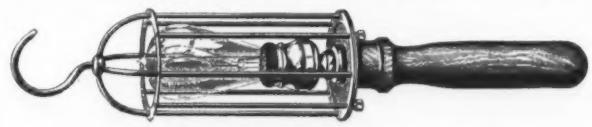
The brushes are readily adjusted while the motor is running, and oil cups with automatic feed keep the motor at the point of proper lubrication.

The fan is mounted on an iron base fitted with starting switch and rubber feet. It throws a good breeze directly forward or can be tilted to an angle either up or down or made into a wall bracket fan by adjusting the wing nuts at the lower sides of the field.

Good dry cells, connected four in each series of five multiples (twenty cells total) will draw so small a fraction of an ampere from each cell as to hold the voltage and enable the battery to stand up to the work. Used only four hours per day, about 300 hours can be obtained. If worked continuously, not allowing the battery to recuperate, the length of life is, of course, greatly reduced. Where constant work is necessary, as in a sick room, etc., it is more economical to have extra sets of battery. Two storage cells, or two or three acid cells, according to the amount of current back of them, will also give good results.

Portable Lamp Guard.

A new portable lamp guard is the latest addition to the "Crescent" line manufactured by the Crescent Company, of Chicago. After



LAMP GUARD.

many experiments the concern is able to furnish a portable lamp guard designed for all requirements. Its construction is such that, while it is strong enough to withstand the hard usage of an engine or boiler room, it is sufficiently ornamental for offices. As will be seen it is provided at one end with a hook for suspension and at the other end with a handle, so that it can be carried around easily and safely.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Values in the stock market at the close of the week were irregular at concessions following a recovery from a general decline earlier in the week. Bearish influences arising from the disturbed financial situation abroad and railroad cutting at home accounted for the decline. The public took little interest in the market, which was narrow in consequence. The heaviness of the trunk line shares, particularly Pennsylvania, was noted, and New York Central later became conspicuous. Brooklyn Rapid Transit and Amalgamated Copper also became active and advanced with ease. The United States Steel shares were steady at first, but afterwards became quite weak and were depressed by renewed unfavorable reports about the earnings of the corporation. Prices on the curb for outside securities generally sagged in sympathy with the main market. The largest transactions were in rights at a lower range of prices. There were a few scattering sales of New York & New Jersey Telephone rights at 3⅝. Interurban Rapid Transit closed at 102, being a net gain of ⅛. Tractions are all lower. Brooklyn Rapid Transit closed at 39⅜, which represents a loss of 1 point. Manhattan Elevated closed at 141½, rallying from 140¾, and Metropolitan Street Railway closed at 114½, which is ½ above the lowest price and a net loss of 1½ points. In the electric list a loss of 5 points net is recorded in General Electric, which closed at 158 after having reached 163. Westinghouse closed at 158, which is a loss of 1 point compared with the closing price of the previous week. Western Union gained ½ point, closing at 87½, and Commercial Cable was off 5 points, the closing quotation being 187. Following are the closing prices of March 1:

NEW YORK.

	Feb. 23	Mar. 1		Feb. 23	Mar. 1
American Tel. & Cable	82	84	General Electric	158¾	159
American Tel. & Tel.	118	121	Hudson River Tel.	..	..
American Dist. Tel.	22	22	Metropolitan St. Ry.	114⅝	114⅝
Brooklyn Rapid Transit	38⅞	40⅛	N. E. Elec. Veh. Trns.	..	..
Commercial Cable	..	188	N. Y. & N. J. Tel.	..	..
Electric Boat	..	20	Marconi Tel.	..	..
Electric Boat pfd.	..	49	Western Union Tel.	86⅝	87⅛
Electric Lead Reduction	..	¾	Westinghouse com.	154	156¾
Electric Vehicle	..	7⅛	Westinghouse pfd.	170	175
Electric Vehicle pfd.	..	10			

BOSTON.

	Feb. 23	Mar. 1		Feb. 23	Mar. 1
American Tel. & Tel	120	120¾	Western Tel. & Tel. pfd.	77	78
Cumberland Telephone	114½	114½	Mexican Telephone	1⅛	1⅛
Edison Elec. Illum.	234	230	New England Telephone	118	118
General Electric	158	157	Mass. Elec. Ry.	18⅜	18
Western Tel. & Tel	9	8¼	Mass. Elec. Ry. pfd.	74¼	73¾

PHILADELPHIA.

	Feb. 23	Mar. 1		Feb. 23	Mar. 1
American Railways	44	43	Phila. Traction	..	..
Elec. Storage Battery	53	52	Phila. Electric	5¾	6⅛
Elec. Storage Battery pfd.	53	52	Phila. Rapid Trans.	14	14⅜
Elec. Co. of America	7¾	7⅞			

CHICAGO.

	Feb. 23	Mar. 1		Feb. 23	Mar.
Central Union Tel.	..	..	National Carbon pfd.	97	98
Chicago Edison	..	..	Metropolitan Elev. com.	17	1
Chicago City Ry		160	Union Traction	4¼	4⅛
Chicago Tel. Co	..	..	Union Traction pfd.	29¼	30
National Carbon	25	25¾			

*Asked

NATIONAL CARBON.—The annual report of the National Carbon Company for the year ending January 31, 1904, already quoted in these columns, showed net earnings of $736,441 compared with $594,372 the previous year. The increase was $142,069, or about 24 per cent. Net earnings for the year just reported amounted to 7 per cent. on the $4,500,000 preferred stock, and to 7.6 per cent. on the $5,500,000 common. Nothing was paid, however, on the common, the company charging off the greater part of the surplus after preferred dividends. This has been done every year since organization, in 1899. The company has made a good record of earnings. The following table compares income accounts for the five-year period 1899-1904:

	Net earn.	Pfd. div.	Balance.	P. C. on common.	Charged off.
1904	$736,441	$315,000	$421,441	7.6	$280,429
1899	451,687	315,000	136,687	2.4	100,000
Increase	284,754	.....	136,687	5.2	180,429

This good showing is also evident in the balance sheets in the form of increased working capital. The following table compares working capital at the beginning and at the end of the five-year period:

	1904.	1899.
Current assets	$1,368,129	$890,424
Current liabilities	93,570	154,479
Net working capital	$1,274,559	$735,945

The working capital shows an increase of over $500,000. Meanwhile there have been additions and improvements made to the property. The demand for carbons, quite outside the lighting field, becomes yearly more varied and the output gains in bulk and value.

COMMERCIAL CABLE COMBINATION.—It is reported that a new company will be formed which will offer its preferred stock share for share for Commercial Cable stock and issue a bonus in common stock. It was said that the new company might be formed for the purpose of combining the Commercial Cable Company and the Commercial Pacific Cable Company, which is the company incorporated in 1901 to lay and operate the cable from California to the Philippines and China. The authorized capital stock of this company is $12,000,000, and it is controlled by the Commercial Cable interests. The Commercial Cable Company increased its stock about a year ago and it was said then that a part of the $1,666,000 increase would go toward completing the Pacific cable. The cable company's stock is $15,000,000, and its bonded debt $20,000,000. This week Mr. Clarence Mackay has given out details of the scheme and has just organized an investment trust under the name of "The Mackay Companies," the design of which is to perpetuate the name of his father, the late John W. Mackay; to provide for the development of the companies which John W. Mackay founded and to safeguard, upon an even basis with Clarence H. Mackay's own, the interests of those who have invested capital in the enterprises with which his father was identified. "The Mackay Companies" has authorized for exchange for the stock noted above $30,000,000 par value of its own 4 per cent. cumulative preferred shares and a like amount of common shares, so that each stockholder in the cable company will receive for his holdings 200 per cent. in the preferred and 200 per cent. in the common shares of the new concern.

NIAGARA, LOCKPORT AND ONTARIO POWER.—Opposition is being made to the plans of the above enterprise. Julius Henry Cohen, chairman of the Legislative Committee of the Citizens' Union has given out a statement condemning the Assembly bill amending the charter of the Niagara, Lockport and Ontario Power Company. He says: "It is a measure which deserves the attention and condemnation of the press, not only in New York City, but throughout the State." The Citizens' Union recognized the danger in this bill and asked for a hearing before the Assembly Committee on General Laws. The delegation which went to Albany and opposed the bill came away with the general assurance that it would be materially amended. But the bill is, in its amended form, a dangerous measure. Here is a company which was given a franchise ten years ago. It has not yet spent one cent on actual construction. It is now proposed to extend its time, to give it the right to deface Niagara, without any compensation to the State, and to give it extraordinary franchise rights in every city and town of the State. The pretended probition in the amendment does not prohibit it for, by combining with a local company in any city or town, it will have a perfect franchise, even in New York City, to rip up the streets, lay conduits, erect poles, and exercise any other powers enumerated above."

NORDEN-BITTNER ELECTRIC COMPANY.—A petition in bankruptcy has been filed against the Norden-Bittner Electric Company, manufacturer of electric supplies, of New York City, by the following creditors: Munder Electric Company, of Springfield, Mass., $816; Joseph George, $68, and O. E. Nantel, $16. It is alleged that the company is insolvent, and in January and February transferred cash to certain creditors to prefer them. John Bittner was president and treasurer, and M. Norden secretary and manager. It was incorporated on August 16, 1901, with a capital stock of $100,000. Judge Holt of the United States District Court appointed Job E. Hedges receiver of the assets on the application of Stern, Singer & Barr, attorneys for the petitioning creditors, who stated that the assets are about $8,000, of which $5,000 are collectable accounts and the balance merchandise. The cause of the bankruptcy petition was the withdrawal of Mr. Bittner, as he declined to advance any more money to the corporation.

ST. LOUIS LIGHTING.—The stockholders of the Laclede Gas Light Company of St. Louis, which is controlled by the North American Company, will hold a special meeting on April 18 to vote upon a proposition to increase the common stock from $8,500,000 to $17,500,000, making the total capital, including preferred stock, $20,000,000. A vote will be taken at the same time on increasing the bonded indebtedness from $10,000,000 to $20,000,000. In a circular to the stockholders, President C. W. Wetmore of the North American Company says that $5,000,000 cash will be needed before February 1, 1905, to meet expenditures for improvements and extensions incidental, largely, to the contracts of the company for the St. Louis Exposition period. The fresh capital will also provide for the development of the business of the company for a series of years. It was said that a local banking house was prepared to take the entire $10,000,000 issue of Laclede bonds and that there would be no syndicate to handle them.

NEW YORK AND NEW JERSEY BELL TELEPHONE.—The New York and New Jersey Telephone Company has issued its full report for the year ended December 31, 1903. Below are some of the figures:

	1903.	1902.	1901.	1900.
Gross	$4,741,344	$3,962,597	$3,376,433	$2,827,481
Expenses	3,269,996	2,823,458	2,294,633	2,018,603
Net	$1,471,348	$1,139,139	$1,081,800	$808,878
Charges and taxes	181,214	166,350	174,104	174,731
Surplus	$1,290,134	$972,789	$907,696	$634,147
Dividends	852,216	707,627	616,286	490,650
Surplus	$437,918	$265,162	$291,410	$143,497

Earnings and expenses in detail follow:

Gross earnings:				
Exchange service	$2,262,289	$1,903,707	$1,633,319	$1,372,916
Pay stations	596,031	490,294	428,996	356,560
Tolls	1,656,943	1,365,854	1,162,279	965,341
Leased lines and instruments	23,730	.....	.....	.....
Real estate	132,803	113,415	107,415	83,939
Other sources	69,547	89,327	44,424	48,725
Total	$4,741,344	$3,962,547	$3,376,433	$2,827,481
Expenses:				
General	$761,541	$646,240	$536,665	$504,613
Operating	761,331	594,730	522,071	460,840
Reconstruction and maintenance	1,446,050	1,330,172	997,828	847,649
Instrument rental	219,950	181,616	176,855	147,417
Real estate	81,124	70,699	61,214	58,085
Total	$3,269,996	$2,823,457	$2,294,633	$2,018,603

BALTIMORE UNITED RAILWAYS.—The United Railway & Electric Company of Baltimore reports as follows for the year ended December 31, 1903:

	1903.	1902.	Changes.
Gross	$5,480,629	$5,041,275	Inc. $439,354
Expenses	2,554,241	2,252,133	Inc. 302,108
Net	$2,926,388	$2,789,142	Inc. $137,246
Other income	90,374	53,405	Inc. 36,969
Total income	$3,016,762	$2,842,547	Inc. $174,215
Changes	2,708,030	2,637,115	Inc. 70,915
Sulplus	$308,732	$205,432	Inc. $103,300

CANADIAN BELL TELEPHONE.—The Bell Telephone Company of Canada makes a satisfactory annual report as follows for the year ended December 31, 1903:

	1903.	1902.	Changes.
Gross	$2,522,275	$2,085,134	Inc. $437,141
Expenses	1,940,123	1,580,852	Inc. 359,271
Net	$582,152	$504,282	Inc. $77,870
Dividends	467,510	.....	.....
Surplus	$114,642	.....	.....

The capital stock of the company is $6,000,000, of which the American Telephone and Telegraph Company owns $2,314,700.

UNION SWITCH & SIGNAL COMPANY.—The following is a summary of the annual report of the Union Switch & Signal Company for the year ending December 31, 1903, as compared with previous years:

	1903.	1902.	1901.	1900.
Gross receipts	$2,132,835	$1,774,005	$1,605,649	$1,690,319
Interest and other disbursements	1,803,513	1,420,322	1,308,143	1,300,406
Net	$329,322	$353,683	$297,506	$389,913
Preferred dividends	130,867	79,726	79,726	79,726
Surplus	$198,455	$273,957	$217,780	$310,187

DIVIDENDS.—West Jersey and Seashore Railroad directors have declared the regular semi-annual dividend of 2½ per cent., payable March 15. The South Side Elevated, Chicago, has declared the regular quarterly dividend of 1 per cent., payable March 31.

Commercial Intelligence.

THE WEEK IN TRADE.—Winter's icy grip on trade seems to be relaxing, according to reports from the various sections, and although severe weather conditions still exist in some, spring trade is asserting itself. Distributive trade in the South has been good and generally in excess of a year ago, and the milder weather has brought out more country buyers. In the East spring trade is growing, but retail business is still restricted by the continued cold weather. Manufacturing plants are gradually restoring idle machinery, and there is more disposition to anticipate future requirements. In the building trades there is every indication of activity with the advent of spring. The cold weather still hampers outdoor operations, but several very large transactions in lumber are reported from the West and Northwest. Baltimore concerns are resuming in temporary quarters, stocks of goods being accumulated with great rapidity, but no permits have been issued for rebuilding the burned district, as plans are in preparation for realignment of the streets. Foreign commerce at New York for the last week shows a loss of $2,489,799 in exports and a decrease of $2,549,672 in imports as compared with the same week last year. The strength of the wheat market, and of the coarser grains, which is looked for to increase, and of provisions generally, are the leading features of the price situation. War talk is still an influence tending to strengthen food products, but to depress raw cotton. Collections are still unsatisfactory at most Northern markets. Money is easy and deposits show increases at leading centers. Railway earnings are not as encouraging as in the past, owing partly to the congestion growing out of blockaded shipments, but partly to cutting of grain freight rates, which, despite the small movement at present, affects the situation appreciably. Iron and steel are still irregular, but the tendency, as a whole, has been in the direction of improvement, owing to the enlarged demand reported for finished products, notably bars, wire and wire goods, steel pipe, and light and heavy hardware. The liabilities of the commercial failures thus far reported for February aggregated $10,796,166, of which $2,732,453 were in manufacturing, $4,290,235 in trading, and $3,773,453 in other commercial lines. *Bradstreet's* summary of business failures for the week ending February 25 shows that there were 200, against 23 the week previous, and 185 the corresponding week last year. Copper remains unchanged, dullness still being the prevalent condition in the market. Quotations are, for Lake, 12½ to 12¾.; electrolytic and casting stock, 12⅜ to 12⅝c. The exports so far in February show a marked falling off, the shipments amounting to but 8,800 tons.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, has recently closed a number of contracts for the installation of batteries of "Chloride" accumulators. Among them may be noted two batteries of the North Shore Railroad Company, one to be located at San Anselmo, Cal., having a capacity of 846 kw, the other located at Sausalito, Cal., having a capacity of 975 kw. Both these batteries to be used for line regulation. The Bay City Traction and Electric Company, Bay City, Mich., have contracted for a battery having a capacity of 288 kw, to regulate the fluctuations of the generator lead. The Northwestern Fuel Company, Superior, Wis., have contracted for a battery having a capacity of 677 kw, which is to be used entirely for the regulation of a motor load. The Bartlett Illuminating Company will install for the use of the Saginaw Traction Company a battery having a capacity of 200 kw, to be used in regulating the fluctuations on the latter company's railway circuit.

NEW POWER STATION FOR NEW ORLEANS.—The construction of a new power station is contemplated by the New Orleans (La.) Railway Company, for which concern Sanderson & Porter, 52 William Street, New York, are the consulting engineers. The proposed new plant will have an initial capacity of 7,000 hp, while eventually it will be capable of developing 20,000 hp. Alternating-current equipment will be installed.

MEXICAN WATER POWER PROJECT.—Mexican advices state that L. B. Cabellero, of Mexico City, has secured the necessary concession from the Secretaria de Fomento by which he is permitted to utilize 3,000 liters of water per second from the Realito River of Tubares, in the District of Andres del Rio, State of Chihuahua. The current so generated will be used for lighting and general power purposes in that vicinity.

CORTLAND (N. Y.) PLANT TO BE REMODELED.—The power station of the Cortland County Traction Company, Cortland, N. Y., is to be remodeled. The existing equipment consists of Watertown engines and belt-driven General Electric railway generators. Two new 200-kw generators will be installed. Jeremiah J. Kennedy, Exchange Court, New York, is consulting engineer.

EQUIPMENT FOR GOUBERT PLANT.—The Goubert Manufacturing Company, 85 Liberty Street, New York, will award contracts shortly for considerable electrical equipment to be installed at its new plant, Bayonne, N. J., where, in addition to the feed-water heaters, steam separators and other specialties of the company, large castings, such as engine cylinders and marine engine work, will be turned out. There will be four foundry buildings, one being 70 ft. x 310 ft. and three, each measuring 60 ft. x 310 ft. The larger building will be equipped with a 40-ton, also a 25-ton electric traveling crane, and each of the other buildings will have a 25-ton equipment. The machine shop will be 90 ft. x 400 ft. The equipment will be operated electrically, the larger tools being driven by individual motors, while the smaller ones will be worked by means of line shafting operated by motors. The power plant will be of 300-hp capacity. The engine will be direct-connected to the generator and of compound non-condensing type. The boilers are to be water tube equipped with superheaters. There will also be a blacksmith shop and plate shop, and various other buildings for storage, pattern-making and similar purposes. Industrial railways will be installed in the plant so as to connect the buildings and supplement the crane and railroad service, as a spur of the Central Railroad of New Jersey will be run to the works, which are located on the water front.

ELECTRIFICATION OF SOUTH AUSTRALIAN STEAM LINES.—Regarding the proposed electrification of the suburban railways in South Australia, advices state that for working the Port Adelaide and Glenelg lines, three alternative schemes are outlined in a report recently prepared on the subject by the Railways Commissioner and leading officers of the department. Two of the schemes are on the high-tension system with one power station, and one on the low-tension system with two power stations. The third scheme has been recommended for acceptance in view of its being the least expensive both as regards installation and as to maintenance. T. Roberts, the chief mechanical engineer of the South Australian Railways, estimated the capital cost at about $1,500,000 and the annual cost at about $170,000, provision being made for 48 cars and as many trailers. The Railways Commissioner, Alan G. Pendleton, thinks the work should be carried out on this scheme. As difficulties are anticipated in operating cars successfully in and out of the Adelaide station, an estimate has been made of bringing the cars into North Terrace by a deviation from the Port line. Such a deviation is calculated to incur an expenditure of $150,000—$125,000 for the track and $25,000 for electrification.

AMERICAN SIGNALING FOR YERKES.—The Underground Electric Railways Company, Limited, of London (usually referred to as the Yerkes' Syndicate), which is constructing an extensive underground and surface electric traction system in and around the British metropolis, has decided to utilize an American system of signaling on the 15 miles of double track of the Metropolitan District Railway. The contract has been awarded to the Westinghouse Brake Company, Limited, of Kings Cross, London, N., which concern has the British rights to manufacture the specialties of the Union Switch and Signal Company, of Swissvale, Pa. The signals will be operated automatically on the Westinghouse electro-pneumatic system and are to be about 300 in number. The service in the tunnels will be arranged for trains running at intervals of 1¼ minutes. A new form of combined signal motor and arm will be employed. This system has been in service for several months past on the Ealing-Harrow experimental section of the Metropolitan District Railway. This is the first instance of a British electric railway to be automatically signaled by means of track circuits.

THE ST. LOUIS SMELTING AND REFINING COMPANY of St. Louis, Mo., is erecting a new smelter at Collinsville, Ill. After considering the matter, on the advice of its consulting engineer, Mr. Henry Floy, of New York City, it has decided to use electric power throughout and has placed orders with the General Electric Company for three-phase motors, varying in size from 75 hp down, and a 240-volt alternator, to be direct connected to a Rice & Sargent tandem, compound engine, operating at 150 r.p.m. The Babcock & Wilcox Co. has been awarded the contract for boilers; the Deane Steam Pump Company has received the order for pumps, and the Buffalo Forge Company, the order for blowers. It is expected the plant will be in operation by July 1, 1904.

BELL TELEPHONE OUTPUT.—The American Telephone and Telegraph Company instrument statement for the month ended January 30, is as follows:

	1904.	1903.	1902.
Gross output	90,644	129,837	87,412
Returned	36,854	43,286	34,796
Net output	53,790	86,551	52,616
Total outstanding	3,833,307	3,236,871	2,578,626

While there is a large total gain over last year, there is an apparent decline in net for the month of nearly 33,000 instruments, the net being barely in excess of the same month in 1902.

THE RIO TAMASOPO SUGAR COMPANY, of which Col. Russell B. Harrison, of Indianapolis, is president, will shortly be in the market for considerable electrical equipment, etc., to be installed on its plantation known as the Agua Buena Hacienda, located about 130 miles west of Tampico, Mexico. A horse tramway is now used for the purpose of hauling the sugarcane from the fields to the mill and conveying the sugar thence to the Mexican Central Railroad at Tamasopo, a distance of about five miles. This line will be converted into an electric traction system. A lighting plant will also be installed for lighting the sugar factory and other buildings on the plantation. The sugar mills are to be operated by water power.

DODGE & DAY, modernizing and contracting engineers, Nicetown, Philadelphia, Pa., are installing in the power house of the Link-Belt Engineering Company, Philadelphia, Pa., a 340-hp Buckeye vertical cross-compound engine, direct-connected to two General Electric 100-kw direct-current, compound-wound generators. The boiler plant at the same establishment is also receiving attention, and while it may not be found necessary to increase the capacity, it is probable under-feed stokers will be introduced. The Taylor system of management is well underway at the Link-Belt Works, and the results attained have been most gratifying.

TRUMBULL SPECIALTIES FOR MEXICO.—Adolphe A. Chaillet, formerly technical director of the Shelby, O., Lamp Company, is now located in Mexico City, where he is primarily interested in a project to manufacture incandescent lamps for that market. He also represents the Mexican interests of a number of United States manufacturers of electrical equipment supplies, etc., and has placed a substantial contract for fusible cleat rosettes, plug cut-outs, switches and other specialties, with the Trumbull Electric Manufacturing Company, New York, offices 136 Liberty Street.

THE FRENCH THOMSON-HOUSTON COMPANY has received a new order from the Paris Metropolitan Railway for 100 complete train control equipments similar to those in use on the Central London Railway, Great Northern and City Railway, the Northeastern Railway and the Metropolitan and District Railway. This order is all for new equipment in addition to that heretofore in use or on order, and is said to be the only additional equipment ordered by the Paris Metropolitan.

ELECTRIC SUPPLY CO., of 298 Second Street, Memphis, Tenn., is having a new store and warehouse built for it in that city, which it expects will be ready for occupancy about May 1. This warehouse will enable it to increase materially the supply stock carried. It proposes also to do a general jobbing business throughout the South. Mr. C. H. Harvey is president, and Mr. W. M. Deming is secretary and treasurer.

MAGNET WIRE ORDERS.—The Magnet Wire Company, 80 William street, New York, report receipt of a quantity of inquiries for feeder cable and trolley wires from the South and Middle West, as well as in this section. A substantial contract for feeder cable has just been secured from the Rochester (N. Y.) Railway Company, and the Pittsburg (Pa.) Coal Company has also sent in a good-sized order for trolley wire, etc.

THE POWER AND MINING MACHINERY COMPANY, of Cudahy, Wis., is enlarging a plant, and in connection therewith desires a number of electric motors, in capacity of 5 to 50 hp, constant speed, wound for 220 volts. The main office of this company is 52 William Street, New York, where the bids and correspondence in connection with this matter will be received.

EQUIPMENT FOR NEW STURTEVANT HOTEL.—The new Sturtevant Hotel under construction at Twenty-ninth street and Broadway, New York, which is being built by the George A. Fuller Company, is to be installed with two 225-hp Harrisburg engines, each directed connected to 150-kw C. & C. generators, and two 120-hp direct-connected to 75-kw C. & C. generators.

HOBART ELECTRIC MFG. CO., of Troy, Ohio, is contemplating the erection of a brick addition to its factory, 220 by 50 feet. It will use its own power plant, but will need additional machinery and tools. It had not let any contracts at the time of writing, but is expecting to have some of them closed immediately.

LIGHTING.—Orders are expected within the next few days for lighting equipment to be installed in the New York plant of the Federal Sugar Refining Company. There will be about 3,000 incandescent lamps. Edward R. Knowles, 136 Liberty Street, is acting as the consulting engineer in the matter.

TRACTION FOR ADELAIDE, AUSTRALIA.—Private advices from Adelaide state that it is confidently expected that the existing horse tramways in that South Australian city will shortly be converted into electric traction. The present lines are about 30 miles long.

UTILIZING HAT RAPIDS, WIS.—A company to be known as the Rhinelander Power Company has been organized with the following officers: A. W. Shelton, president; E. A. Forbes, vice-president; Charles Chafee, treasurer, and C. A. Wixson, secretary. The power company is capitalized at $85,000, $40,000 of which has been subscribed by the above named, some of whom are connected with the Rhinelander Electric Light Company, and who will begin at once the development of the excellent water power a few miles below Rhinelander, Wis., known as Hat Rapids. Their first move will be to have a new and accurate survey made of the power, and follow it up with the construction of a dam, giving a 20-ft. head, and which it is estimated will be capable of developing up to 1,500 hp. The concern will be a lighting and power company, and there is not the slightest doubt that there will be a demand for all the power developed. The Rhinelander Manufacturing Company, the Wisconsin Veneer Company, the Rhinelander Paper Company, the Rhinelander Iron Company, the city pumping station, etc., will be in the market for electric power as soon as the development is completed and the current turned on. An estimate of the time required for the completion of the work is given as six months.

OTIS ELEVATORS FOR YERKES' LONDON SYSTEM.—The Otis Elevator Company, Limited, of London, has been alloted the contract for the "lifts" for the whole of the Yerkes' system of tube railways in the British metropolis. The elevators will be operated by power transmitted from the central station at Chelsea. There will be 170 elevators in all, capable of carrying an average of 65 passengers at a time, or nearly 100,000 people all told. The speed will be 200 feet per minute. The underground stations will be fitted in most cases with four and in some cases six elevators each. The average rise will be 60 feet. The machinery will be of the Otis type and special safety appliances and non-flammable material are to be employed throughout the mechanism and its accesories. The shafts will vary from 40 feet to 180 feet in depth; the majority of the shafts will be 23 feet in diameter and some will be 30 feet in diameter. It is expected that the bulk of the equipment will be manufactured on the other side. The contract, which is the most valuable ever let for elevators on either side of the Atlantic, will represent an expenditure of upwards of $1,750,000.

DUTY ON ARC CARBONS.—Judge Lacombe in the United States Circuit Court of Appeals in New York City last week decided the case of the United States versus R. F. Downing & Co., in favor of the importers, thereby materially reducing the duty to be exacted on carbons for electric arc lights. These carbons, in the condition in which they are used, are 12 inches long, and they are specifically provided for in the tariff law at 90 cents a hundred. Some years ago the importers tried bringing them in in longer lengths, from 12½ to 20 inches, and the claim was made that they were entitled to classification as articles manufactured of carbon at 35 per cent. This claim was overruled by General Appraiser Fischer on November 7, 1901, and Judge Henderson M. Somerville wrote a dissenting opinion sustaining the importers' claim. This dissenting opinion is now confirmed by the Circuit Court of Appeals. The importers were represented by Comstock & Brown.

INTERNATIONAL TELEPHONE CONTRACTS.—Among the contracts recently secured in the Northwest by Mr. Henry Shafer, president of the International Telephone Manufacturing Company of Chicago, was one for a 1,000-line capacity central energy lamp signal double supervisory switchboard, distributing board, lightning arresters, complete power plant, together with a 50-number self-restoring drop country party line and tollboard for re-equipping the exchange of the Portage Telephone Company, Portage, Wis., and telephones for increasing the exchange. The Portage company will use its present generator-call telephones on the system, by cutting out the generator and cutting in an International condenser, thus changing them to centralized calling energy local talking battery instruments.

NEW STURTEVANT WORKS.—The boiler plant of the B. F. Sturtevant Company's new works at Hyde Park, Mass., is now in full operation. This plant comprises three 250-hp Stirling boilers equipped with Jones under-feed stokers, air for which is furnished by a 6 ft. x 28 in. Sturtevant steam fan operating at 2½ oz. pressure, a 9 x 4½ ft. Sturtevant induced draft steam fan, and an economizer (to be installed later) of their own make. The maximum steam pressure carried will be 150 pounds. Fire was started under these boilers on December 23. This company has in process of construction a 400-hp vertical compound engine with direct-connected 250-kw generating set, which will be the first of several units to be installed in the engine room.

THE NERNST LAMP COMPANY has appointed Mr. G. E. Bennett to act as district sales manager of its Buffalo district office, recently established at 17 West Mohawk Street. These quarters will include an office, show room, exhibition room and stock room, with a complete stock of lamps and supplies to meet the requirements of the trade in this territory. The company has recently closed contracts for the installation of 165 Nernst lamps in the Washington National Bank Building, and 75 lamps for the Pittsburg Supply Company, at Pittsburg, Pa. It has also succeeded in securing the adoption of Nernst lamps by the municipal electric light plant of Silverton, Colo., in competition with enclosed arc lamps.

MEXICAN HYDRAULIC PROJECT.—A hydraulic plant is to be constructed on the river Alaja in the San Miguel Allende district, State of Guanajuato, Mexico. Jose de J. Garcia has been granted the necessary concession from the Mexican authorities which permits of the utilization of 1,500 liters per second. The usual franchises and obligations are embodied in the concession. A deposit of $5,000 in bonds of the Mexican 3 per cent. consolidated silver debt has been made by the concessionaire. Construction work is expected to be begun immediately and orders will be placed here very shortly for the necessary equipment. The plant will develop current for general power use.

BRIDGEPORT, CONN., MANUFACTURING PLANT.—The Eaton, Cole & Burnham Company, manufacturers of steam fixtures, etc., is to install considerable electrical equipment in its plant now being extended at Bridgeport, Conn. A Westinghouse turbine of 400-kw capacity will be put in. There will also be installed 31 Westinghouse motors varying in capacity from 5 hp to 30 hp and aggregating 350 hp. A 30-kw General Electric direct-connected exciter set has also been ordered. G. K. Hooper, Bowling Green Building, New York, is the consulting expert.

MEXICO CITY LINES EXTENDED.—The Mexico Electric Tramways Company (usually known as the Wernher-Beit system), which operates an extensive electric traction system in Mexico City and suburbs, proposes to construct a further line. The company has filed an application with the Department of Public Communications in the Mexican capital for the necessary authorization to build a line from Nino Perdido, on the south, to Los Angeles on the north side, thus forming a complete circuit.

EQUIPMENT FOR HOTEL NETHERLANDS.—Mackenzie, Quarrien & Ferguson, 114 Liberty Street, New York, have taken an order for a 150-hp Harrisburg side-crank engine for direct connection to a 100-kw Western Electric generator. The equipment will be used for lighting the Hotel Netherlands. The New York Dock Company has ordered a 75-hp Harrisburg standard simple engine for direct connection to a 50-kw General Electric generator for lighting purposes.

THE CATAWBA POWER COMPANY has secured the contract for lighting the streets of Charlotte, N. C., and advises that it is now in the market for pole line supplies for eighteen miles of transmission, high potential circuit. It is also in the market for the necessary supplies for wiring the city of Charlotte for 155 arc lamps and for private lighting and small motor work. Mr. W. S. Lee, Jr., is vice-president and general manager.

CHANGES IN CUBAN TARIFF.—Under the new Cuban tariff, which has just gone into effect, there is a 25 per cent. increase in the duty on copper wire, copper wire gauze, cables and miscellaneous articles. There is a 30 per cent. increase on incandescent lamps of all kinds, electrical insulators and electric conduits. There is a 25 per cent. increase on dynamo electric machinery, "inductors and detached parts."

AMERICAN ELECTRIC TELEPHONE ORDERS.—Among switchboard shipments recently made by the American Electric Telephone Company of Chicago are the following: Monroe, Neb., one 100-line express; Belize, British Honduras, C. A., one 200-line express; Olivet, Kan., one 100-line express; Dunlop, Ia., one 200-line express; Topeka, Kan., one 40-line express.

BALL ENGINE ORDER.—The Cleveland Arcade Company, Cleveland, O., has contracted with the Ball Engine Company, Erie, Pa., for one of its 400-hp heavy duty side crank engines, arranged for direct-connection to a Westinghouse generator. This is a new design which has been much admired by those who have seen it.

TO LIGHT CAMPECHE CITY.—The city of Campeche, capital of the State of Campeche, Mexico, is to be illuminated by electricity. The city has a population of about 22,000. The lighting equipment will be purchased in the United States. Don Luis Garcia, a prominent lawyer, is one of the principal parties interested in the project.

ELECTRIC TRACTION FOR NEW ZEALAND.—The Australasian electrical, engineering and contracting firm of Noyes Bros. has been awarded the contract for the construction and equipment of an electric traction system in Invercargill, a prosperous seaport town located in the extreme south of New Zealand.

JAPANESE LIGHTING PLANT EXTENDED.—The Yokohama (Japan) Union Electric Light Co. is to double the capacity of its plant, making 1,200 hp in all. Two 300-hp Heine boilers have been ordered. The initial boiler equipment is also of Heine build.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

(Published first issue of each month.)

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, C. J. Reed, 929 Chestnut Street, Philadelphia, Pa. General meeting, Washington, D. C., April 7, 8 and 9, 1904.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. C. E. Skinner, New Haven, Conn.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, 95 Liberty Street, New York. Meetings, last Friday each month.

AMERICAN RAILWAY, MECHANICAL & ELECTRICAL ASSOCIATION. Secretary, Walter Mower, 12 Woodward Avenue, Detroit, Mich.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Brooklyn, N. Y. Next meeting, St. Louis, 1904.

AMERICAN STREET RAILWAY ASSOCIATION. Secretary, T. C. Pennington, 2020 State Street, Chicago.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. S. Barstow, New York City and Portland, Ore.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Hamilton, Ont., 1904.

COLORADO ELECTRIC LIGHT, POWER & RAILWAY ASSOCIATION. Secretary, George B. Tripp, Colorado Springs, Col. Annual meeting last Wednesday in October.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, E. W. Poole, Bridgeport, Conn. Annual meeting in November.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, F. P. Ide, Springfield, Ill. Next meeting, December, 1903.

ELECTRICAL TRADES SOCIETY (Member National Electrical Trades Association). Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets second Friday of each month.

ILLINOIS STATE ELECTRIC ASSOCIATION. Secretary, H. E. Chubbuck, LaSalle, Ill.

INDIANA PUBLIC UTILITIES ASSOCIATION. Secretary, A. M. Barron, Indianapolis, Ind.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES. Secretary, Frank G. Jones.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA. Secretary, E. W. Pichardt, Huntingburg, Ind.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, New York.

INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, E. M. Coleman, Louisville, Ky.

IOWA ELECTRICAL ASSOCIATION. Secretary, W. S. Porter, Eldora, Ia.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Des Moines, Ia. Annual meeting, Des Moines, March 8, 1904.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James Maret, Mount Vernon, Ind.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress Street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby Street, Boston, Mass. Meets second Wednesday of each month, except July and August.

NATIONAL ARM, PIN & BRACKET ASSOCIATION. Secretary, J. B. Magers, Madison, Ind. Next meeting, St. Louis, July, 1904.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 44 Whitesboro Street, Utica, N. Y. Next meeting, St. Louis, Mo., September 14, 15 and 16, 1904.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, Ernest H. Davis, Williamsport, Pa. Next meeting, Boston, Mass., May 24, 25 and 26, 1904.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, J. H. Neal, 101 Milk Street, Boston, Mass. Meets last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, 114 Liberty Street, New York.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, T. R. Mercein, 85 Michigan Street, Milwaukee, Wis.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Chas. Currie, Akron, Ohio.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Secretary, C. J. Miller, Canton, Ohio.

SOUTHWESTERN ELECTRICAL ASSOCIATION. Secretary, J. L. Ellis, Oklahoma City, Okla. Next meeting, Dallas, April or May, 1904.

SOUTHWESTERN GAS, ELECTRIC & STREET RAILWAY ASSOCIATION. Secretary, Frank E. Scovill, Austin, Texas.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA. Secretary, W. B. Brockway, 40 Morris Street, Yonkers, N. Y.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK. Secretary, W. W. Cole, Elmira, N. Y. Next meeting, Utica, N. Y., Oct. 11 and 12, 1904.

UNITED ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, F. Fish, Rochester, N. Y.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury, Vt.

WESTERN SOCIETY OF ENGINEERS. Next meeting of Electrical Section, Chicago, March 18, 1904.

General News.

THE TELEPHONE.

MONTGOMERY, ALA.—The Middletown & Wellsville telephone line has been organized here, with Jeff Haygood as president.

JOLIET, ILL.—The building of the Chicago Telephone Company here has been destroyed by fire.

JOHNSON CITY, ILL.—The Good Service Telephone Company has been incorporated with a capital stock of $2500. The directors are J. E. Poindexter and others.

CHICAGO, ILL.—It has been officially stated that the Chicago Telephone Company will erect an eight-story building on Washington St., next to the Title & Trust Bldg., in which place its present exchange is located and which it has outgrown. It will be several months before the company issues any new stock, as the exchequer is well supplied with immediate funds.

LIBERTY CENTER, IND.—The Liberty Center Telephone Company has filed articles of incorporation. The capital stock is $2500. James P. Mounsey, L. A. Minnear and O. D. Garrett are the directors.

LANDESSVILLE, IND.—The Landessville Rural Telephone Company has increased its capital stock to $9975, for the purpose of making extensions and improvements. Henry Wine is president, and Rudy Freeman, secretary.

GREENFIELD, IND.—The Vernon Township Farmers' Telephone Company, of Hancock County, has filed articles of incorporation with the Secretary of State. The capital stock is $1000. George M. Rumler, John Hiday, C. J. Jackson and others are directors.

CONNERSVILLE, IND.—A stockholders' meeting of the Connersville Telephone Company was held in this city recently. The directors elected George M. Sinks president, W. T. Edwards vice-president, and L. A. Frazee secretary and treasurer. The secretary reported over 700 telephones in operation.

MARION, IND.—C. C. Huff, a country school teacher of this county, has used the telephone successfully in teaching absent pupils. For two weeks the family of James Hewitt has been quarantined because of small-pox in the family. Two of Mr. Hewitt's sons are anxious to graduate this year, and for them to miss school rendered this result doubtful. The teacher suggested the telephone. For two weeks Mr. Huff assigned the lessons to the lads and heard them recite each evening over the telephone. They are now back in school and well up with their class, due to the use of the telephone.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company is rapidly installing new instruments in the burnt district. Fortunately for the company, it had a switchboard stored away in Washington. This is now installed and in working order. The Maryland Telephone & Telegraph Company was little harmed by the fire save in the loss of instruments and distributing poles in the burnt district. It is busy supplying telephones to all subscribers who have opened temporary offices.

HERMOSILLO, MEX.—A long distance telephone line is to be built between this city and Guaymas. A. Mascarenas, cashier of the Banco Sonora, Chihuahua, Mexico, can give information.

TORREON, MEX.—The Government has granted a concession to M. A. Sepulveda, of the Torreon Telephone Company, to extend its lines to the towns of Gomez Palacio, Lerdo and adjacent haciendas. The concession also authorizes the company to extend its lines to the cities of Durango, Monterey, Saltillo, Mapimi and other places. All of the principal towns and cities of northern Mexico are to be included in the proposed system.

ALPENA, MICH.—Mr. C. H. Reynolds has been elected president of the Alpena Mutual Telephone Company, and Mr. W. H. Johnson secretary and treasurer.

MONROE CITY, MO.—J. M. Griggsby, of Goss, president of the Monroe Mutual Telephone Company, met about 75 farmers in this city February 20 and formed a mutual company that will work in connection with the county lines.

CLAYTON, MO.—At a meeting of the directors and stockholders of the St. Louis County Telephone Company, in this city, it was decided to begin work on the new line within the next 30 days. The offer of telephones for $1 a month for residences and $1.50 a month for business establishments will be discontinued after March 14.

ST. LOUIS, MO.—At a meeting of the directors of the Bell Telephone Company of Missouri, February 23, Cyrus P. Walbridge was elected president to succeed F. P. Fish, of Boston. It is stated that Mr. Fish, who is president of the American Telephone & Telegraph Company, could not give his time to both organizations. The officers elected, besides Mr. Walbridge, were Edwards Whitaker, vice-president; Fritz Nisbet, secretary and treasurer, and George F. Durant, general manager. The following directors were elected at a previous meeting of the stockholders: Cyrus P. Walbridge, D. S. Smith, William Duncan, John A. Holmes, James Campbell, P. C. Maffit, F. P. Fish, Casper Yost, A. Bert, George F. Durant and Edwards Whitaker.

AVOCA, NEB.—A number of farmers here have formed a new company to be known as the Avoca Telephone Cobpany, No. 4.

LINCOLN, NEB.—The Phelps County Telephone Company has been incorporated with a capital stock of $40,000. The directors are C. W. Stiger and others.

PIKE, N. Y.—The Pike Telephone Company has been incorporated with a capital stock of $1000 by G. S. Van Gorden, Henry C. Lathrop and Fred W. Gild, Pike, N. Y.

ALBANY, N. Y.—The Big Eddy Telephone Company has been incorporated with a capital stock of $8000. The directors are: Frank Kinnie, G. W. Engleman and others.

JASPER, N. Y.—The Jasper & Canisteo Telephone Company has been incorporated with a capital stock of $300. The incorporators are: Willis A. Schency, Dr. Walter Benedict, Jasper; Ray Jamison, Canisteo.

ASHLAND, OHIO.—The Central Union Telephone Company will install an exchange at this place.

HICKSVILLE, OHIO.—The Hicksville Telephone Company has increased its capital from $25,000 to $40,000.

WARREN, OHIO.—The Phalanx & Leavittsburg Telephone Company is considering the extension of its system.

DAYTON, OHIO.—The Home Telephone Company, of Dayton, has increased its capital from $600,000 to $1,000,000.

WALDO, OHIO.—The Waldo Home Telephone Company has been incorporated with a capital stock of $25,000. The directors are A. Osborn and others.

GALLIPOLIS, OHIO.—A new telephone company has been organized in Green Township to connect with the Gallipolis Telephone Company. Among the stockholders are B. and E. Wadell and J. W. Ecker.

COLUMBIANA, OHIO.—The Fairfield Township Mutual Telephone Company is being organized to build an independent telephone system in Fairfield township. Farmers in the vicinity are interested in the enterprise. Among the promoters are: O. C. Vanskiver, Harvey Woods, John Wisler and J. W. Weaver.

CINCINNATI, OHIO.—The Cincinnati & Suburban (Bell) Telephone Company continues to show a substantial increase in its business, and the number of applicants for surface is still on the increase. The annual report, which will soon be forthcoming, will make an excellent showing. The company has been paying dividends of 6 per cent. per annum, but recently the stock has advanced from 140 to above 160.

TONKAWA, OKLA.—The Farmers' Mutual Telephone Company has been incorporated with a capital stock of $2500 to $10,000.

GUTHRIE, OKLA.—The Pioneer Telephone & Telegraph Company, with headquarters here, has been chartered to operate telephone lines and district telegraph or messenger systems. The capital stock is said to be $3,000,000. The company is a merger of several independent telephone companies in Oklahoma and Indian Territory.

PENDLETON, ORE.—The Wild Horse Telephone Company has been incorporated with a capital stock of $1000. The directors are W. M. Blakely and others.

WASHINGTON, PA.—The Buffalo & Hopewell Township Telephone Company has been formed, with J. H. Stewart as president.

INDIANA, PA.—About twenty farmers in the vicinity of Shelocta have formed a local telephone company. Wm. Rankin is president of the new company.

COLUMBIA, S. C.—A bill has been introduced in the legislature of South Carolina fixing a schedule of telephone rates for city and country on a basis of $1.50 for residences and $2 for places of business in exchanges of less than 250 subscribers, and $2.50 for residences and $3.50 for business houses in exchanges of 1200 subscribers or over, and a proportionate scale for intermediate size exchanges.

HUDSON, S. D.—The Hudson Telephone Company is contemplating building a large number of exchanges throughout the country districts during the present year. At a recent meeting of the stockholders the following named officers were elected: President, E. D. Cassil; vice-president, O. C. Olson; secretary, E. R. Buck; treasurer, F. B. Cable.

PORT LAVACA, TEX.—The Port Lavaca Telephone Company will make important improvements.

HOUSTON, TEX.—The Citizens' Telephone Company has extended its long distance telephone line to Sour Lake, Tex., from Houston.

BROWNSVILLE, TEX.—The Western Union Telegraph Company will extend its telegraph line from Corpus Christi to this place, a distance of about 175 miles.

AUSTIN, TEX.—The Southwestern Telegraph & Telephone Company announces that improvements to cost about $20,000 will be made to the local system of the company.

SOUR LAKE, TEX.—The Higgins Oil & Fuel Company has constructed a telephone line from this place to Batson, Tex., a distance of about 18 miles. It will be used for the private business of the company.

MENARDVILLE, TEX.—The Menard Telephone Company, of Menardville, has just completed a telephone line to Hext, a distance of 15 miles, and will soon commence the construction of a line to McKavill, Tex.

SAN ANTONIO, TEX.—Col. J. E. Farnsworth, of Dallas, Tex., announces that the Southwestern Telegraph & Telephone Company, of which he is manager, will expend about $80,000 in making improvements and extensions to its local system at San Antonio. Engineers are now preparing the plans for the proposed work.

LULING, TEX.—The City Council of Luling has granted a franchise to the Independent Telephone Company to establish and operate a telephone exchange here. It is announced by the officers of this company that it will immediately begin the construction of a long distance telephone line to connect San Antonio and Houston, a distance of 225 miles. Among the men interested in the company are: H. W. Flato, of San Antonio, Tex.; T. H. Spear, of New York, and George Cornelius, of Minneapolis, Minn.

MONTPELIER, VT.—The New England Telephone Company will build a new line from Burlington to Rutland.

ST. ALBANS, VT.—The independent telephone companies of northern and central Vermont held a meeting recently at St. Johnsbury and decided to build a trunk line from St. Johnsbury to Montpelier. It is the purpose of the independent companies to build trunk lines and ultimately reach all parts of the state.

GANDEVILLE, W. VA.—The Spencer, Gandeville & Weston Telephone Company has been incorporated with a capital stock of $75,000. The directors are: E. Johnson, L. A. Rader and others.

BARRON, WIS.—The Barron County Telephone Company has increased its capital stock from $2500 to $22,500.

ELECTRIC LIGHT AND POWER.

KEMPS CREEK, ALA.—A franchise for an electric plant has been granted to Frank F. Taylor.

EAST LAKE, ALA.—It is proposed to construct an electric light plant, at a cost of $10,000. Robt. A. Morris is chairman of the committee.

ANNISTON, ALA.—The Coosa Water Power Development Company, of Anniston, has been chartered, with a capital of $250,000, to develop the water power of Coosa River for the benefit of Anniston, Pell City and other places.

BIRMINGHAM, ALA.—The City Council and the citizens of the west end are considering the construction of water works and an electric light plant.

DARDANELLE, ARK.—Bonds to the amount of about $7000 will be issued for the construction of an electric light plant.

FORDYCE, ARK.—The Fordyce Light & Water Company has been chartered with a capital of $20,000. It will furnish lights for the town and factories. B. H. Wood, president; John R. Hampton, secretary.

ALHAMBRA, CAL.—The Pacific Light & Power Company, Los Angeles, has secured the electric light franchise.

FERNDALE, CAL.—W. W. Barnes, secretary of the Ferndale Electric Light Company, writes that about $8000 will be expended in improvements.

CORONA, CAL.—The Temescal Water Company, of this place, is making extensive improvements. It is building laterals and digging wells. One of the largest improvements is an electrical transmission line in course of construction between Ethanac and Temescal, 20 miles. At Ethanac the company has a number of good wells, heretofore pumped with gasoline and steam engines, requiring large quantities of oil and distillate, which had to be hauled 20 miles from Corona at heavy expense. Now the pumps will be driven by electric motors. The workmen building the electric line will have a comfortable house on wheels in which to live. Poles have been ordered from Washington State, and it is expected the line will be in operation in six weeks. The improvements will cost $15,000.

DELAWARE CITY, DEL.—W. T. Smith, Mayor, writes that it is proposed to construct a lighting plant.

JONESBORO, GA.—The citizens have voted to issue bonds for an electric light plant.

DOUGLAS, GA.—Bids will be received March 7 by C. E. Baker, City Treasurer, for $20,000 electric light and water bonds.

BUENA VISTA, GA.—Geo. R. Lowe, Recorder, states that the town is contemplating letting a franchise for an electric light plant.

COVINGTON, GA.—The development of two important water powers near Covington, on Alcova River, is said to be practically assured. N. S. Turner, W. C. Clark and C. H. White are the incorporators of a company which expects soon to begin the work of development of the two falls. Thirty thousand dollars have already been subscribed to the stock of the company, and this sum will be considerably increased. The water power available is said to be 14,000 horse-power. It is proposed to supply energy for lighting the city of Covington and for operating the Covington & Oxford Street Railway and other plants.

LENA, ILL.—The business men are considering the construction of an electric light plant.

KIRKWOOD, ILL.—A franchise for an electric light plant has been granted to the Kirkwood Electric Company.

VIRDEN, ILL.—The Virden Electric Light Company, of Virden, has been incorporated, with a capital of $15,000. Incorporators: J. N. Hairgrove, U. G. Tucker and C. W. Carr.

CICERO, IND.—The Town Board is taking steps toward constructing an electric light plant.

NEW HAVEN, IND.—The Town Trustees have decided to construct an electric light plant.

INDIANAPOLIS, IND.—The Indiana Supreme Court has decided that the franchise granted by the town of Booneville to the Booneville Electric Light & Power Company for laying pipes, putting up poles and wires to supply light, heat and power, is void, because the ordinance was never published as provided by statute. It is now probable the company will be enjoined from further service until a new franchise is procured.

LEWISTON, IDA.—The Lewiston Water & Power Company has determined to develop the water power near the mouth of Grand Ronde River. The improvement will cost about $1,000,000. The company also proposes increasing the capacity of its present plant from 1200 to 2000 horse-power.

WALNUT, IA.—Bids are being received for furnishing material and constructing a complete electric light and power plant here. A. R. Longnecker is Town Clerk.

OGDEN, IA.—Bids will be received on March 15 for an electric light plant of 1800 lights, a gas plant of 1800 lights, and a combined gas and electric plant. Address City Recorder.

FT. DES MOINES, IA.—Bids will be received by Maj. R. B. Turner, Q. M., U. S. A., Observatory Office Building, Des Moines, on March 16 for an electric lighting system at Ft. Des Moines.

YATES CENTER, KAN.—It is reported that the Council wishes to grant franchises to a private company to establish electric lighting at this place.

WEST GARDINER, ME.—Jas. Carver and A. L. Childs, of Auburn, are among those interested in a proposed electric power enterprise, on Cobbossee stream at Cram's Mills in West Gardiner, and about two miles below the outlet of Lake Cobbosseecontee. The new owners will increase its capacity from 350 to 500 horse-power by raising the dam. They propose to sell power in Augusta, Hallowell and Gardiner.

MERRIMAC, MASS.—It was voted on January 30 to construct an electric light plant.

NEGAUNEE, MICH.—Rockwell Bros. are to construct a new gas and electric plant at Negaunee.

SOUTH STILLWATER, MINN.—The question of issuing bonds to the amount of $10,000 or $15,000 for an electric lighting plant will be voted on the second Tuesday in March.

CULIACAN, MEX.—Bids are wanted March 31 for constructing an electric light plant. Address Senor Gen. Don Francisco Canedo, Culiacan, Sinaloa.

SAN CRISTOBAL, MEX.—Henry T. Lecert, representing a New York syndicate, is investigating the situation here with the view of establishing an electric light and power plant.

VILARDENA, MEX.—An electric power plant to cost about $50,000 is to be installed here by the American-Mexico Mining & Development Company to furnish power for the machinery at its mines. Dr. W. S. Phillips, of Chicago, Ill., is president of the company.

IRAPUATO, MEX.—An electric power plant will be installed here by Richard A. Barkley for the purpose of furnishing power to operate his four large flour mills, paint works and other industrial concerns.

SAN MIGUEL ALLENDE, MEX.—Jose de J. Garcia has been granted a concession by the Mexican Government to establish an electric power plant on the Laja River near here. He is authorized to use 1500 liters of water per second for the purpose.

TAMASOPA, MEX.—The Rio Tamasopa Sugar Company will install an electric light and power plant on its large plantation, situated near here. The plant will also furnish power for operating an electric freight railway on the plantation. Among those interested in the company are: Dr. John D. Cattic, of Anderson, Ind.; C. A. Smart, of Wild Rose, Wis., and Col. Russell B. Harrison, of Indianapolis, Ind.

COLUMBIA, MO.—A bond issue of $10,000 was voted February 23 for the purchase by the city of Columbia of the water works and electric light plant owned by the Columbia Water & Light Company, which holds the franchise for the supply of water and light to the town. The plant will be purchased for $67,000, and will be improved.

LEXINGTON, NEB.—Bids are wanted for a franchise for an electric light plant.

FREMONT, NEB.—It is reported that the municipal light station will be enlarged by an addition 30x60 ft., in which machinery will be installed, at a cost of $8000.

OXFORD, N. C.—A proposition has been made to the town to put in electric lights and water works, the town to rent the same.

CHARLOTTE, N. C.—The Light Committee has recommended that the city make a contract with the Catawba Power Company, of Ft. Mill, S. C., to supply lights at $54 per year for the first 150 lights and $48 for all over that number.

HARRISON, N. J.—The Town Council has granted a franchise to the United Electric Company to lay underground conduits in Harrison.

ANADARKO, OKLA.—The citizens have voted to issue bonds for the construction of an electric light plant.

KINGSTON, ONT.—The water power at Kingston mills on Rideau Canal has been secured by J. M. Campbell, and he will install an electric plant. A well to permit a fall of 52 ft. will be constructed.

PENDLETON, ORE.—By the filing of a notice of water appropriation at Pendleton, February 8, the Northwestern Gas & Electric Company, of Walla Walla, Wash., took the first step toward carrying out its plan of constructing a power plant on Walla Walla River near Pendleton. The company will furnish electric power for heating and manufacturing purposes in Walla Walla, Pendleton, Athena and other towns.

MT. UNION, PA.—It was voted February 16 to issue $12,000 bonds for an electric plant.

WILKESBARRE, PA.—The Select Council has granted a franchise to the Ashley Electric Light Company. It refused to grant a franchise to the West Side Electric Light Company.

NEW CASTLE, PA.—Robt. Hunt & Company, of Pittsburg, have submitted plans and estimates for a municipal electric light plant. They estimate the cost of buildings, equipment, etc., at $65,415, and cost of operation, $18 per day.

SHIPPENSBURG, PA.—It is stated that arrangements are being perfected for the merging of the Shippensburg Gas Company and the Electric Light & Power Company into the Shippensburg Heat, Light & Power Company. The electric power will be furnished by water about two miles distant from the borough.

STEWARTSTOWN, PA.—The directors of the recently chartered Deer Creek Water & Power Company organized in Stewartstown on February 13, with Jas. H. Gable, of York, president. The company proposes to construct a dam and power plant on Deer Creek, one mile from Stewartstown, and when completed will furnish water, power and light to Stewartstown and vicinity.

LEXINGTON, S. C.—The State Senate has passed the bill authorizing the Lexington Power Company to build dams across Saluda River.

GROTON, S. D.—Herman E. Miles, of St. Paul, Minn., has secured a franchise for an electric light, gas and central heating plant.

COLUMBIA, TENN.—The Louisville & Nashville Railroad Company intends to build a water power and electric light plant at Bigby Creek. The expenditure involved will be between $12,000 and $15,000.

COLUMBIA, TENN.—Bids are wanted for building and equipping an electric light plant to furnish the city with lights. It is desired to let contracts for 60 arc lights, and at end of the term a further satisfactory contract to be entered into, or the plant is to be sold to the city at an appraised valuation. It is contemplated that this plant shall also furnish incandescent lights to private parties. W. A. Dale is chairman of the Light Committee.

PORT LAVACA, TEX.—C. J. Spettae, of Panhandle, Tex., is arranging to install an electric light and power plant at this place.

UVALDE, TEX.—An eectric light plant is to be installed here by W. H. Rose. He also contemplates building a street railway here.

HARDWICK, VT.—This village contemplates increasing the power for its electric light plant.

ELLENSBURG, WASH.—Bids are wanted March 7 for an electric light plant. It is to be operated by turbine wheels of 640 horsepower, and 240-kw dynamos will be installed. Estimated cost, $22,000.

SPOKANE, WASH.—A power company which proposes to utilize the waters of the Spokane River about 20 miles from here in the Big Bend territory, for furnishing electric lights, will shortly be organized here. A 20,000-hp plant will be established, from which electrical energy will be furnished to the large flour mills at Big Bend and for the lighting of numerous small cities in that vicinity. Surveys have already been made, and the route of the pole lines to Spokane was decided upon some months ago. David Wilson is the chief promotor of the enterprise, and has made all necessary arrangements in the east whereby work can be commenced in the very near future. At the point where it is proposed to establish the power plant, a fall of 33 feet can be utilized. Eastern investors will furnish most of the capital for the enterprise.

MONTICELLO, WIS.—A municipal electric light plant is proposed here.

EAST MILWAUKEE, WIS.—The Milwaukee Light, Heat & Traction Company, of Milwaukee, has petitioned for a franchise to light the village.

BELOIT, WIS.—Bids were called for March 3 for the construction of an electric light plant, to cost between $30,000 and $40,000. D. H. Foster is City Clerk. Robert Caldwell, City Engineer.

RHINELANDER, WIS.—The Rhinelander Power Company, of Rhinelander, has been incorporated, with a capital of $85,000, by E. A. Forbes, C. A. Wixson, R. C. Dayton and others, to improve and develop water power in the Wisconsin and other rivers.

NEENAH, WIS.—The Wisconsin Traction, Heat, Light & Power Company, operating the electric interurban line between Neenah and Kaukauna, has petitioned the City Council for a franchise to light the city. The company offers to furnish street lights at $65 per year on an all-night schedule.

THE ELECTRIC RAILWAY.

CHICAGO, ILL.—There is to be a meeting of the stockholders of the South Side Elevated Railroad Company on April 7, to vote on the question of increasing the capital stock to carry out the plans for extensions, as outlined by President Carter at the recent annual meeting.

VINCENNES, IND.—The Vincennes, West Baden & Louisville Traction Company has asked for a $50,000 subsidy, and an election has been ordered for March 12.

LEXINGTON, KY.—O. M. Baker, of Hamilton, O., and George Nowall, of Cincinnati, have taken the contract for building the line of the Paris & Georgetown Traction Company, between Franklin and Versailles.

BANGOR, ME.—Surveys are now being made for the proposed electric railway from Bangor to Dexter, Me., and it is expected that construction work will be begun on the line this summer. The line will be 30 miles in length. The overhead trolley will be used. Power to operate the line will probably be developed from water sources. The officers of the company are: H. F. Bailey, of Bangor, president; E. B. Weeks, of Old Town, treasurer; F. J. Martin, of Bangor, attorney and clerk; F. T. Dow, of Bangor, engineer.

AUGUSTA, ME.—The Northern Main Seaport Railroad Company has been incorporated to build an electric railway from a point in connection with the Bangor & Aroostook Railroad at La Grange, to a point in connection with the Maine Central Railroad near the northwest line of the city of Belfast, with two spurs or branches to tidewater, one in Stockton Springs and one in Searsport. The length of the road is to be 60 miles, and the company is capitalized at $360,000. The directors are: Edward Stetson, B. B. Thatcher, F. H. Appleton, F. W. Cram and H. P. Oliver, of Bangor.

ST. LOUIS, MO.—The Alton, Granite City & St. Louis Electric Railroad has been organized at Alton, with a capital of $100,000. The organizers are: J. F. Porter, W. E. Porter, H. S. Baker, H. E. Weeks and Levi Davis.

KANSAS CITY, MO.—A franchise has been granted to the St. Joseph, Parkville & Kansas City Railway Company for an electric railway through this county from Harlem to the Platte County line.

KANSAS CITY, MO.—The Kansas City & Olathe Electric Railway Company has awarded the contract for the construction of its power plant to the Union Construction Company, of Kansas City. The plant will be located at Lackman, Kan.

NEW YORK, N. Y.—The name of the Interurban Street Railway Company has been changed to New York City Railway Company.

ADA, OHIO.—Thomas C. Childs, of Akron, has obtained a franchise in Ada for the line which will be built from Lima to Kenton.

DAYTON, OHIO.—The Interstate Traction Company has applied for a franchise in Montgomery County for a proposed line from Dayton to Indianapolis.

CLEVELAND, OHIO.—The Eastern Construction Company has closed a contract for building the line of the Warren, Courtland & Jefferson Traction Company.

CANTON, OHIO.—The Canton-Akron Railway Company is in the market for a 600-hp boiler, six 12-bench open cars, six 18-ft. box cars with 67 motors and all other parts necessary to complete cars.

NEW INDUSTRIAL COMPANIES.

THE H. O. S. ENGINEERING COMPANY has been incorporated in New York with a capital of $15,000. The directors are: J. A. Aitkin, W. H. Brearley and W. A. Thompson, of New York.

THE JORDAN AUTOMATIC SIGNAL COMPANY of New York has been incorporated with a capital stock of $1,000,000. The directors are: W. H. Jordan, C. C. Jordan and J. F. Jordan, New York.

RADIUM INCANDESCENT LIGHT COMPANY of New York, with a capital stock of $15,000, is of recent corporation. The directors are: J. Perk, Brooklyn; S. Wolfson and I. Wigdor, New York.

THE UNITED ELECTRICAL MANUFACTURING COMPANY has been incorporated in New York with a capital stock of $1000. The directors are: E. F. Buchanan, A. O. Brown and L. G. Young, New York.

THE PHYSICIANS' ELECTRICAL MANUFACTURING COMPANY of New York has been incorporated with a capital stock of $10,000. The directors are: F. E. Hodgskin, G. A. Wingate and A. B. Reed, New York.

THE GENERAL LIGHTING & HEATING COMPANY of New York has been incorporated with a capital stock of $20,000. The directors are: Stanley Francis, W. A. Smith and G. D. Moffatt, New York.

THE WATSON-FLAGG ENGINEERING COMPANY of Paterson, N. J., has been incorporated with a capital stock of $125,000. The incorporators are: George H. Watson, John L. Flagg and Frank J. Huttin.

THE MUNICIPAL ELECTRIC & CONSTRUCTION COMPANY has filed articles of incorporation with a capital stock of $50,000. The incorporators are: Charles G. Diemunch, William Gottlieb and Joseph Block.

THE CHARLES Q. TYSON COMPANY, of Dayton, O., electrical contractor, has been incorporated with a capital of $10,000, by P. W. Tyson, C. O. Waxler, H. H. Wolloston, G. W. Chaffin and R. W. Baggott.

THE WESTERN RAILWAY SIGNAL COMPANY has been incorporated at Camden, N. J.; capital, $60,000. Incorporators: John G. Bennett, Walter C. Beckworth, Philip Peter, Joseph H. Phillips and Josh B. Chapman.

THE NEW YORK F. E. COMPANY has been incorporated to deal in electrical supplies. The capital stock is $1000, and the directors are: W. H. McClain and C. L. McFetrish, New York; Edward Butcher, Jr., Brooklyn.

THE FALLER AUTOMATIC TELEPHONE EXCHANGE COMPANY of New York has been incorporated with a capital of $10,000. The directors are: J. W. Chisholm, E. A. Faller, New York; Clarkson Clothier, Philadelphia.

THE WITHERBEE IGNITER COMPANY has been incorporated in Jersey City with a capital stock of $50,000. The incorporators are: Thomas S. Witherbee, Albert E. Milliken, Mervyn A. Rice, Thomas Mullally.

FAURE-PRICE ELECTRIC COMPANY has been incorporated in New York with a capital stock of $25,000. The directors are: J. P. Faure, New York; E. A. Watson, Brooklyn, and E. H. Price, Rutherford, N. J.

THE MONTEREY LIGHT & POWER COMPANY has been incorporated in Jersey City, N. J., with a capital of $50,000. The incorporators are: K. K. McLaren, Jersey City; Robert L. Hoguet and Robert H. Williams, New York City.

THE LIEBER-FOYE AUTOMOBILE COMPANY, of St. Louis, Mo., has filed articles of incorporation with a capital stock of $4000, full paid. The incorporators are: William B. Foye, Otto Lieber, Miss Ida E. Foye and Paul V. James.

THE POLYPHASE IGNITION SYSTEM COMPANY, of New York City, has been incorporated to deal in electrical machinery. The capital stock is $50,000, and the directors are: R. L. Heitemeyer, Hoboken, N. J.; G. G. Schreiber and W. B. Symmes, New York.

THE AUTOMOBILE TRANSIT COMPANY, of St. Louis, has filed articles of incorporation with a capital stock of $12,500, full paid. The incorporators are: O. P. Langan, A. G. Lewis, G. F. W. E. Eggert, L. B. Langan, C. H. Cuncker, A. D. Anderson and Myron Peers.

LEGAL.

THE CHICAGO MOTOR VEHICLE COMPANY has, according to press dispatches from Chicago, been placed in charge of a receiver by Judge Tuthill, of the Circuit Court. The action was taken on the application of two stockholders who, it is stated, claimed that they would be defrauded if a proposed plan to divert the assets of the company were carried out. Mr. Edwin S. Day was appointed to take charge of the company's affairs.

INDEPENDENT TELEPHONY IN NEW YORK.—The Appellate Division of the New York Supreme Court handed down a decision affirming an order by Justice Clarke at Special Term denying a motion for a peremptory writ of mandamus asked for by the Independent Telephone Company, of New York, to compel Robert Grier Monroe, then Commissioner of Water Supply, Gas and Electricity, to issue a certan permit. The company had asked for a permit to lay and maintain telephone wires in the low-tension subway and have additional subways of the kind constructed in various localities. Commissioner Monroe refused to grant the permit on the ground that he had been advised that the company had no franchise or right to construct and maintain such structures and fixtures as were asked for. The order denying the motion was affirmed by the Appellate Division, but without opinion. Justice Laughlin dissents. In a brief opinion he says: "The transportation corporation law, under which relator was incorporated, gives it a franchise, and it is, without obtaining any further franchise from the Municipal Assembly, in a position to apply to the respondent for a permit pursuant to the provisions of Section 528 of the Greater New York charter, which must be entertained and granted upon such reasonable terms, conditions and restrictions as may be imposed by the respondent, pursuant to any provisions of law applicable thereto."

FESSENDEN LIQUID BARRETTER PATENT.—The National Electric Signalling Company has brought suit in the United States Circuit Court, Southern District of New York, against the DeForest Wireless Telegraph Company, the American DeForest Company, Abraham White, president of said companies, and Lee DeForest, scientific director, for infringement of Reissue Letters Patent No. 12,115, of May 26, 1903, to Reginald A. Fessenden. This patent is for the well-known liquid barretter or receiver for wireless telegraphy, and describes the liquid barretter as having resulted from the discovery that when a loop of the Fessenden solid barretter or hot wire receiver is broken while dipping in nitric acid it works even better than before. In this case the resistance change is a decrease instead of an increase, and it is localized in the minute layer of the liquid next to the wire, instead of in the wire. The patent mentions a platinum wire forty one-millionths of an inch in diameter dipping into dilute nitric acid or other conducting liquid. For six months this receiver has been used by the National Electric Signalling Company, transmitting 20 regular messages a day each way over 80 miles of land between their stations at Jersey City and Collingswood, a suburb of Philadelphia. This has been accomplished with transmitting apparatus using a quarter of a horse-power of electrical energy, and in recent tests this has been cut down to a tenth and even a fifteenth of a horse-power. Professor Fessenden claims to have patented this invention more than nine months ago, and it was fully described in the technical press in September, 1903. (See ELECTRICAL WORLD AND ENGINEER, New York, September 19, 1903, page 272.)

OBITUARY.

MR. S. B. FAIRCHILDS.—Mr. Sidney B. Fairchilds, one of the oldest telegraphers in the United States, and father-in-law of Frederick MacMonnies, the sculptor, died at St. Louis on February 27, aged 72. Mr. Fairchilds had been employed by the Western Union Telegraph Company in that city for 39 years, and for many years had been night wire chief. In point of age and service he was the oldest member of the telegraphers' association known as "The Old-Timers."

MR. W. G. McMILLAN.—We regret deeply to note the death from pleurisy of Mr. Walter George McMillan, the secretary of the Institution of Electrical Engineers of England, an office he had held with great acceptance since 1897. He was educated at King's College, London, where he also taught metallurgy, in which he lectured later at Mason College, Birmingham. He served also as a Government chemist and metallurgist, and at the time of his death was an examiner in metallurgy for the City & Guilds of London Institute. He was only 43 years of age. He has left a widow and two young sons, and the Council of the Institution has now started a memorial fund, which will be invested for the benefit of his widow and for the education of these fatherless boys. American visitors will recall Mr. McMillan's quiet and unremitting efforts in 1900, to promote their welfare and comfort during the foreign trip of the Institute.

EDUCATIONAL.

LYNN GENERAL ELECTRIC ENGINEERING SOCIETY, of Lynn, Mass., is carrying out a splendid programme of papers and visits this winter, with meetings about once a month regularly, and other specialties interspersed. Dr. F. A. C. Perrine has just lectured on "Electricity from the Waterfall," and Prof. H. E. Clifford is down for a special course on alternating-current theory. The Society, which is thus doing excellent work, is composed principally of the engineers of the General Electric Lynn Works, together with students from the testing department.

COLUMBIA RADIUM EXHIBIT.—Because of the importance and interest attaching to the recent discovery of radium, Columbia University is planning a special exhibit at the St. Louis Exposiion. Mr. F. A. Goetz, superintendent of the university buildings and grounds, will have charge of the enterprise, which will also include an exhibition of the Mineralogical Department. This will show various phases of producing radium. Dr. Tucker, of the Chemical Department, will have charge of the chemical side, and Professor Hallock will superintend the physical, including the methods and the illustrations of radio activity. The Pathological Department of the College of Physicians and Surgeons will give illustrations showing its usefulness in medicines.

PERSONAL.

MR. W. B. PARSONS, M.E., engineer of the New York Subway, has been appointed by President Roosevelt a member of the Panama Canal Commission.

MR. R. H. COKER, formerly of Washington, D. C., has been appointed agent of the Colorado Telephone Company at Longmont, Col., succeeding Mr. C. F. Bartell.

MR. H. F. GREENWOOD, chief engineer and special manager of the Havana Electric Company, is now in New York. He may be found at the local offices of the company, 52 Broadway.

MR. M. E. CURWEN, European representative of the J. G. Brill Company, of Philadelphia, whose headquarters are in London, has sailed for the other side, after a short visit to this country.

DR. MARGARET A. CLEAVES has issued in pamphlet form her article on the physiological action of light and the physical factors in phototheraphy printed recently in the *Journal of Advanced Therapeutics*.

MR. J. C. BOYNTON has been appointed manager of the Toll Department of the Colorado Telephone Company, with headquarters in Denver. He was previously traffic manager of the Pittsburg Telephone & Printing Company.

MR. HARRY ALEXANDER, of New York City, has opened an office in Boston at 120 Tremont Street, to conduct an electrical contracting business. He is now engineering the electrical work on the new Siegel Building in Boston.

MR. F. J. ALVIN, of the American Electrical Novelty & Manufacturing Company, 308-322 Hudson Street, New York City, has been elected president of the recently formed Foreign Trade Association of America, 66 Broad Street, New York City.

MR. GEORGE BULLOCK, president of the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, who has recently been somewhat seriously indisposed, returned this week from Bermuda, where he has been recuperating for a few weeks.

MR. HENRY SHAFER, president of the International Telephone Manufacturing Company, of Chicago, has been making an extended trip through the Northwest in connection with the growing work of the company in that large and important section.

MR. J. R. LOVEJOY, the head of the electric lighting department, etc., of the General Electric Company at Schenectady, has found it necessary to drop business for a brief rest and has been visiting Hot Springs, Va. His vacation, however, will not be a very long one.

MR. W. A. BRACKENRIDGE, C.E., of the Niagara Falls Power Company, has been appointed by Governor Odell, of New York State, a member of the special advisory commission of five expert engineers who will supervise the construction of the $100,000,000 barge canal.

MR. O. M. C. HEYL will have charge of a new electrical department to be inaugurated by Paul Bergner & Company, Mexico City, in order to cater to the increasing demand for electrical appliances and supplies which has lately sprung up throughout the southern republic.

MESSRS. H. HOBART PORTER, JR., and FRANCIS BLOSSOM, of Sanderson & Porter, New York, have returned from a trip to New Orleans, where they recently went in connection with the proposed power house extension of the New Orleans Railways Company.

MR. THOMAS A. EDISON went South last week and has taken up residence on his plantation near Fort Myers, Fla. He has telegraphed his friends that the orange and lemon trees are in full bloom, which is taken as an intimation that he proposes to drop work for a brief spell.

BELLMAN & SANFORD, New York City, have been appointed engineers by the American Exchange National Bank to prepare plans and specifications for a lighting plant, to be installed in their 16-story bank and office building, corner of Broadway and Cedar Street, New York City.

MR. JAMES I. BUCHANAN, who returned recently from Panama, where he went on a special mission for the United States Government, has sailed for Europe to assume his new position as deputy chairman and managing director of the British Westinghouse Electric & Manufacturing Company, Limited.

MESSRS. T. AHEARN and W. Y. SOPER are the subjects of portraiture and of biographical sketches in connection with an article in the Ottawa *Evening Journal* on the Ottawa, Can., street railway system, which they have built up, in addition to doing a lot of other creditable electrical work all over the Dominion.

MR. FRANK KLEPETO, consulting engineer, New York, has sailed for Peru in reference to the construction of the huge smelting works, etc., of the Cerro de Pasco Mining Company, in which enterprise J. B. Haggin is the moving spirit. Considerable electrical equipment will be purchased within the next few weeks.

MR. CLEMENS HERSCHEL, formerly hydraulic engineer of the Holyoke, Mass., Water Power Company, also consulting hydraulic engineer from time to time during the past score of years of several Niagara water power companies, will have charge of the new water turbine and other hydraulic machinery department of the Allis-Chalmers Company.

MR. ABNER DOBLE, of Abner Doble Company, San Francisco, the pioneer railroad engineer, etc., on the Pacific Coast, has had the misfortune to lose his wife, who accompanied him to the State in 1851. Mrs. Margaret Doble was 73 years old, and leaves four adult children. She and her husband had as Argonauts seen all the wonderful growth of California.

MR. H. D. SCRIBNER, who has been prominently connected with the Westinghouse Electric & Manufacturing Company's Pacific Coast agencies for a number of years, has left San Francisco and opened an office of the Canadian Westinghouse Company in Vancouver, B. C. Mr. Scribner has done much of the early and recent electric railroad building on the Pacific Coast.

MR. E. RATHENAU, as already noted in these columns, has been decorated with others by the Emperor of Germany in connection with the Zossen high-speed electric railway work. This honor has given great pleasure to his host of friends and admirers in America. We understand that the decoration conferred is that of the Order of the Red Eagle, with the clasp.

MR. ERNEST F. LEARNED, formerly with Stone & Webster, of Boston, has arrived in Denver on an extensive vacation tour of the United States. Mr. Learned plans to visit California and Washington before returning east, and he accompanied Mr. C. F. Wallace, of the Stone & Webster management, as far as Chicago, Mr. Wallace going through to Seattle.

MR. S. G. McMEEN, of Chicago, Ill., is in the City of Mexico making preliminary arrangements for the extensions and improvements of the telephone system of the Mexican Telephone Company. This company recently obtained a renewal of its concession from the Mexican Government for a period of 30 years, and under the terms that it was granted certain stipulated improvements are required to be made.

MR. JAMES A. CUMMINGS, who secured the contract for the supplying and laying of the conduits for the new municipal telephone and telegraph lines now under construction in St. Petersburg, Russia, has sailed for Europe after several weeks' visit on this side. The conduit is being manufactured at the Raritan River, N. J., plants of the American Vitrified Conduit Company, Broadway-Maiden Lane Building, New York.

MR. J. L. PUTNAM, who for some years has been general manager of the Clark Automatic Telephone Switchboard Company, of Providence, R. I., and whose personal efforts have resulted in the installation of this system all over the country, has resigned his position to accept one with the Central Union Telephone Company, at Indianapolis, Ind. Mr. Putnam goes to his new work with the best wishes of all his friends, of whom he has a goodly number all over the country.

MR. W. J. HAMMER is out in Colorado and is understood to be making radioactive tests on pitchblende there. Dispatches from Denver speak of his handling pitchblende from Gilpin County, Colorado, where hundreds of tons are in sight at this moment, of high testing quality. Mr. Hammer delivered a lecture on February 26 in Denver, before the Colorado Scientific Society. His subject was "Radium." The lecture was given at the Central Presbyterian Church.

MR. ARTHUR WARREN contributes to the New York *Times* of February 28 a most charming and entertaining article on the "publicity" methods by which a great modern industry can be built up. While no names are given, it is of course an open secret that the Westinghouse interests are those dealt with in this instructive sketch. A number of excellent points are made, and none the less for being presented in admirable literary form. Mr. Warren's story deals with achievement on both sides of the Atlantic. Until quite recently, Mr. Warren had charge of the Westinghouse Publicity Bureau, but resigned to take up other important work.

MR. OSCAR T. CROSBY, the well-known electrical engineer, who penetrated recently to the interior of Thibet, has just returned home to this country. While in England he lectured by invitation before the Royal Geographical Society on his interesting journey. Since his return here, a number of his friends in the American Institute of Electrical Engineers and the New York Electrical Society have united in a formal request to him to give them an evening in New York, when they can listen to the tale of his adventures in that mysterious central region of Asia. It is understood that Mr. Crosby will gratify this wish at an early date.

MR. I. A. BENNETT, general sales manager for the Electric Appliance Company, Chicago, has resigned his post to take effect March 1, and will open the Chicago offices of the Phelps Company, of Detroit, Mich., manufacturers of the Hylo turn-down lamps and other specialties. Mr. Bennett was with this company for about 11 years, having previously been connected with the Ansonia Electric Company. Mr. Bennett has also accepted the presidency of the Central Station Publishing Company, which is being formed for the promotion of central station advertising. His new offices will be located in the Monadnock Building, Rooms 529 and 530.

MR. W. H. COVERDALE.—W. H. Coverdale & Company have recently been incorporated to do a general engineering and contracting business, with offices at 66 Broadway, New York. Their organization includes engineers of experience in all matters relating to the design and construction of steam and electric railroads, lighting and power plants, coal and ore handling machinery, etc. Mr. Coverdale was for many years in the engineering department of the Pennsylvania Lines West of Pittsburg, and was track elevation engineer of that company in Chicago during 1898-99. He was also prominently identified with the construction of the Westinghouse shops at East Pittsburg, and for the last three years has been civil engineer for a New York firm of engineers and contractors. Mr. Charles F. Keene is the secretary of the company.

MR. HENRY C. PAYNE.—Postmaster-General Henry C. Payne denies the imputation of the Wisconsin Independent Telephone Association that he has discriminated against the independent companies in favor of the Bell Company. In a letter to E. A. Wadhams, who is a trustee of the Standard Telephone Company, of Madison, Mr. Payne states that a large number of Bell telephones have been displaced from postoffices by the order, as well as independent telephones. "Each case is taken up on the merits as presented," he said. "You can readily see that long-distance service is a factor, and I think that I am justified in assuming that double service paid for by the Government is unnecessary and the expenditure not justified. Double service in all the postoffices in the United States would cost the Government an enormous amount of money, which I think would not be good business administration."

MR. A. H. VAN CLEVE.—The official anouncement of the appointment of Mr. A. Howell Van Cleve to be resident engineer of the Niagara Falls Power Company and its allied companies has been made by Vice-President Rankine. Mr. Van Cleve will succeed Mr. William A. Brackenridge, who has resigned to accept the appointment as a member of the Advisory Canal Board, recently tendered him by Governor Odell. Mr. Van Cleve has been connected with the engineer corps of the Niagara Falls Power Company continuously since April, 1892, and at the time of his appointment as resident engineer to succeed Mr. Brackenridge he held the position of assistant engineer. He is a graduate of Lehigh University, a member of the class of 1890, with the degree of C.E. Before his connection with the Niagara Falls Power Company he had served on the engineer corps of the Lehigh Valley and the Brooklyn Elevated railroads. He is a member of the Board of Public Works of Niagara Falls.

DIRECTOR OI.—The following item from the Pittsburg *Dispatch* deals with a man well known and admired in this country, and throws light on the progressive methods by which the Japanese have brought themselves abreast of the civilization of Europe and America: "Away back in the early '80s," said a well-known electrician of this city, "there came to me with a letter of introduction from the president of the company, a young Jap, and the note directed me that he be given every opportunity to work in all the departments of the factory, so that he might be proficient in every branch. He was apt, willing, always wore a grin and remained at the place about two years. The boy had been working as a lineman before he appeared at the factory. His name was Oi. He went back to Japan, and only at Christmas time, by a present, was the electrical engineer reminded of him. Many years later the engineer was waited upon by three Japanese who wanted to know all about the very latest devices for telephones and telegraphs. They were electrical engineers and had been taught all they know at the Imperial University in Tokio by a Prof. Oi, from whom they carried a letter of introduction to the engineer. They were Imperial Commissioners, and the engineer took them all over this country explaining things. The brightest of the three was called Wadachi and the others were Nakayama and Okonoto. They told their mentor that Oi was now Minister of Posts and Telegraphs in Japan, and this important position he now holds during war times." The many friends of Prof. Oi in this country know he will not be found wanting in emergencies.

Trade Notes.

THE MAINTENANCE COMPANY, of New York City, has removed its general offices to 54 and 56 Franklin Street.

THE J. B. McKEAGUE COMPANY, which is the Chicago representative of the Empire Electrical Instrument Company and F. A. La Roche Company, has recently changed its address to 324 Dearborn Street, Chicago, Ill.

PRATT & VAN WINKLE, the consulting engineers, of 160 Fifth Avenue, New York City, have issued a neat bulletin as to the merits and special advantages of the Pratt elevator safety for which they are agents. It is illustrated in detail.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has just issued a folder picturing and describing the Greenwood safety wire guard for which it is selling agent. It claims that this guard has many features of value to any electric light man and contractor.

EMPIRE INSULATING CLOTHS AND PAPERS.—The Mica Insulator Company, 218 Water Street, New York, has issued a booklet containing samples of its varied line of Empire insulating cloths and papers. Each sample is accompanied by data relating thereto.

ROTARY PLANERS.—An excellent catalogue has been issued by the Newton Machine Tool Works, Philadelphia, on their rotary planers. These rotary planing machines are built in 11 sizes with heads from 14 inches to 84 inches in diameter over tools. They are built either fixed, portable or on a round base, and either belt or motor driven. Some excellent half tones show the construction of these machines.

H. T. PAISTE COMPANY, Philadelphia, Pa., has issued a neat circular with a view of the Government Printing Office, Washington, D. C., recently described in these pages, and calls attention to the fact that it supplied for that plant no fewer than 16,000 P. K. sockets and 10,000 P. K. fusible ceiling rosettes. These were essentially of the type needed for such a building subject to great vibration on account of the heavy printing press machinery, binders, etc.

THE CENTRAL TELEPHONE AND ELECTRIC COMPANY, 909 Market St., St. Louis, Mo., has issued its World's Fair art catalogue, No. 18, of telephone instruments and switchboards. The various styles of instruments manufactured by this company are clearly illustrated and their special features briefly described. On the right hand pages are shown views of the different principal buildings of the World's Fair. There are also shown some examples of the statuary used in the adornment of these structures.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., in a recent bulletin, shows in illustration of and describes an electrically operated single-spindle slate drill press. The power of this machine is supplied by an Emerson direct-current ¼-hp motor, and is applied directly to the spindle. Another bulletin issued by the company gives the company's terms of sale and telegraph code. The code is very concise and comprehensive, and the idea of putting it in a separate bulletin is a good one.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 32 Cortlandt St., New York, in its catalogue No. 16, just issued, shows a very extensive and varied line of electrical apparatus. About everything excepting dynamos is embraced in the list, which includes a very complete line of telegraph, telephone, electric light and construction supplies and novelties. Fan motors of different standard makes are also given due prominence. The catalogue is very comprehensive in scope, and it is surprising how much can be concentrated in 80 pages. It is very completely illustrated, and gives the prices of the multitude of articles described.

INDUSTRIAL RAILWAY CATALOGUE.—The C. W. Hunt Engineering Company, of West New Brighton, Staten Island. has just issued a very handsome new catalogue, to which it feels warranted in calling special attention as the most complete work of the kind that has been published. In addition to the large number of illustrations, showing the many and varied types of cars, standard and special, which the concern builds, the catalogue also contains much valuable information relating to the "Industrial" railway not to be found elsewhere, particularly of interest to engineers and architects. It will be of much use also to intending purchasers.

"MODERN METHODS" is the appropriate title of a very attractive and interesting pamphlet just issued by the North Electric Company, of Cleveland, O., as its Bulletin No. B-22. It contains 48 pages of text and illustrations and discusses on broad lines telephone policy, equipment, apparatus, management, etc. The admirable apparatus of the North Company is brought out in great detail, and the cuts must be highly commended for their wonderful clearness. The views of the complete switchboards are also excellent to a degree far beyond the ordinary. The handsome cover in colors shows a rural telephone line, and the interior of a busy exchange.

JEFFREY MACHINERY.—The Jeffrey Manufacturing Company, Columbus, O., has recently issued Catalogue No. 57a which will be of interest to certain lines of electrical manufacturing. It is on the subject of machinery for the saw-mill, lumber and wood-working industries. It gives a general idea of the company's elevating and conveying machinery, which can be adapted to almost every known industry. The catalogue is profusely illustrated with views of actual installations and of the apparatus and parts thereof. It contains 144 pages, which give a vast amount of information on the subject in general and specifically. The catalogue is gotten up in the company's usual first-class style, both as to arrangement and completeness.

UNIVERSAL ELECTRICAL DIRECTORY.—This valuable directory for 1904, issued by H. Alabaster, Gatehouse & Co., 4 Ludgate Hill, London, is a remarkable compilation, as usual. It contains the names and addresses of members of the electrical and allied trades and professions throughout the world, and is the oldest and largest electrical directory. It is divided into four sections, *i.e.*, British, with 11,560 names; Continental, with 9420 names; U. S. A., with 7500 names; Colonial, with 3610 names, making a total of 32,090. Each of these sections are again divided into alphabetical and classified sections, and in the case of the British a geographical section is also given. The entire book is carefully revised each year, and the financial information and central station particulars are brought up to date as far as possible.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., have recently sent out a batch of trade literature. Bulletin No. 1051 contains a list of plants operating single-phase "Wood" alternators in the United States on Dec. 1, 1903. Bulletin No. 1052 is devoted to a description and illustrations of the multiple alternating current street arc lighting system. This is a very complete description of the system and is well illustrated with half-tone views of the apparatus and diagrams and curves showing connections and efficiencies. The Fort Wayne Works have also issued instruction books regarding their enclosed alternating current arc lamps of the multiple type and enclosed alternating current multiple system arc lamps of the special transformer type.

THE IMPROVED CINCINNATI AIR COMPRESSOR.—Bulletin L-508 of the Laidaw-Dunn-Gordon Company, of New York, bearing the foregoing title, is devoted to a new type of air compressor, the distinguishing feature of which is the novel manner in which the opening and closing of the exhaust ports are controlled. The exhaust opens through poppet valves, which is desirable, especially where the pressure pumped against is variable. The closing of the exhaust is determined by Corliss valves located in the passages between the cylinder and the poppet valves. These prevent all leakage of air back through the poppet valves while they are closing and also, by providing a cushion of air under full pressure, allow them to seat easily and without noise. The opening and closing of the admission are determined by the Corliss valves entirely.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, has issued a catalogue which—without indulging in a pun—can be designated as a triumph of the engravers' and printers' art. Moreover, the beauty of the production is enhanced by a lack of the striving for effect that often nullifies the object in view, the main factor in the success achieved being a well-balanced combination of excellent engraving and printing, well selected type and fine quality of paper. The few ornamental embellishments are properly subordinated, consisting of initial cuts, front and tail pieces. The catalogue describes and illustrates in detail the line of Triumph electrical machinery, and its application to various uses, direct-connected machine tools occupying considerable space. The half-tone engraving has most successfully stood the severe test entailed in representing this particular class of illustration.

POWER STATION SPECIALTIES.—This pamphlet describes power house auxiliary machinery for vacuum making and boiler feeding recently developed by the Geo. F. Blake Manufacturing Company, 114 Liberty St., New York City. The lists include rotary dry vacuum pumps, vertical cross-compound simplex boiler feed pumps, Admiralty type surface condensers with combined air and circulating pumps, vertical twin air pumps, comined pot-valve outside-packed-plunger duplex feed pumps and centrifugal pumps for circulating condenser water. This apparatus has been designed to meet the exact requirements of steam turbine and reciprocating engine units of 5000 to 10,000 hp capacity, using steam of 200 to 300 lbs. pressure per square inch. For the highest efficiency of each equipment, the vacuum must be as close to the barometer as mechanical means can produce, and it is to secure this end that the machines described in this pamphlet have been designed. The publication is numbered B-62, and will be sent upon request to those interested.

THE ELECTRICAL TESTING LABORATORIES, formerly known as Lamp Testing Bureau, have taken possession of their new quarters at 546 East 80th Street, New York City, and are now prepared to undertake many kinds of electrical and photometrical tests. All of the apparatus formerly installed at 4 Jay Street has been set up in the new laboratories, as also several new instruments which add much to their facilities. The equipment of these laboratories is most liberal and thoroughly up to date, while the technical staff consists of trained specialists and expert assistants. Tests made by the Electrical Testing Laboratories may be relied upon as being highly accurate and altogether satisfactory as to methods and thoroughness. All tests are treated with the strictest confidence, the data and reports being considered the property of the customer for whom the test is made, and are not available for the use of others. Tests are carried out with absolute impartiality, without favor to any one, and with the single object of accurately determining facts as they exist for the information of him who pays for the work.

IMPERIAL CROWN LAMPS.—The Bryan-Marsh Company has furnished us with advanced data as to its Impreial Crown lamp. This lamp consists essentially of the same component parts as the incandescent lamp. It is provided with an aluminum reflector fitting on the top of the bulb that increases the effective illumination and equalizes the distribution of light. It is designed expressly to meet the demand for a larger unit of illumination than afforded by the incandescent lamp where an arc lamp is inconvenient or unsatisfactory. The efficiency of the illumination of the Imperial Crown lamp is, it is claimed, greater than that secured from any other source. The light is uniform, steady, soft and perfectly diffused. The Imperial Crown lamp is suitable for use in connection with the most elaborate scheme of interior decoration. Its artistic outline lends grace and harmony to its surroundings. It is also suitable for concealed illumination and may be built into the walls or ceilings to conceal its outline without affecting its illuminating power. When thus concealed, it is unnoticed except for its light. The Imperial Crown lamp is furnished in two sizes with suitable fixtures.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED FEBRUARY 23, 1904.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

752,589. ELECTROMAGNETIC REVERSING DEVICE; John Riddell, Schenectady, N. Y. App. filed May 28, 1900. Two oppositely rotating magnets for driving a planer, an armature located between them and a switch for throwing the circuit from one to the other at the end of each traverse of the table.

752,643. ELECTRIC PUMP FOR SWITCHING MECHANISMS; Walter J. Bell, Los Angeles, Cal. App. filed July 31, 1903. A solenoid magnet and an automatic circuit controller controlling the flow of oil to the cylinder of a motor which moves a railway switch.

752,649. TELEPHONE ATTACHMENT; George Briggs Buchanan, Haverstraw, N. Y. App. filed Sept. 15, 1902. (See page 476.)

752,659. SAFETY AND SIGNALING DEVICE FOR HOISTING MECHANISM; William N. Dickinson, Jr., Chicago, Ill. App. filed Jan. 4, 1902. A platform switch located at each landing of a dumb waiter, to prevent the car from being moved from any landing at which it is being loaded or unloaded.

752,689. ELECTRICALLY PROPELLED VEHICLE; Louis Krieger, Courbevoie, France. App. filed Feb. 26, 1903. A motor vehicle carrying a gas engine, a dynamo and an electric motor, the dynamo having shunt and series field coils wound in opposition, the series coil being wound to decrease the field excitation as the current increases. It is stated that as the intensity of the current depends upon the effort of traction, if this increases in consequence of an incline of the road, the difference of potential at the terminals of the dynamo at the same time decreases and the vehicle slows down automatically.

752,690. METHOD OF PRODUCING SPARKS IN THE CYLINDERS OF INTERNAL COMBUSTION ENGINES; Leon J. Le Pontois, New Rochelle, N. Y. App. filed Aug. 22, 1903. The method consists in simultaneously breaking two or more alternating currents, differing in phase from each other, thereby insuring a constant heat value of the spark at any given time.

752,691. INDUCTION ALTERNATOR; Leon J. Le Pontois, New Rochelle, N. Y. App. filed Aug. 22, 1903. A design for an alternator whereby sufficient current is produced at low speed to furnish a spark for starting an explosive engine, while at the higher speeds the armature reaction tends to maintain the current constant, notwithstanding speed variations.

752,692. POLYPHASE MAGNETO ALTERNATOR; Leon J. Le Pontois, New Rochelle, N. Y. App. filed Nov. 7, 1903. Details of construction of a generator designed to deliver two or more alternating current differing in phase from each other, such currents being employed for the purpose set forth in patent 752,690.

752,696. ELECTRIC CORD ADJUSTER; Jonathan E. Masterson, Spokane, Wash. App. filed May 23, 1903. A spring drum adapted to take up the slack.

752,705. AUDIPHONE RECEIVER; Hermann G. Pape, Brooklyn, N. Y. App. filed Oct. 21, 1902. (See page 476.)

752,710. MEANS FOR SYNCHRONIZING THE INSTRUMENTS OF TELEPHONE SYSTEMS; Hope Redmon, Rufust L. Hall and Robert H. Conway, Cynthiana, Ky. App. filed Sept. 17, 1903. (See page 476.)

752,719. AUTOMATIC SIGNALING SYSTEM FOR ELECTRIC RAILWAYS; Harry B. Snell, Cement City, Mich. App. filed July 17, 1903. A dial plate and index is located at each end of a block and operated to show motormen the number of cars in a block.

752,722. SWITCHBOARD; Alfred Stromberg, Chicago, Ill. App. filed May 13, 1902. (See page 476.)

752,834. ELECTRICAL RECEPTACLE; Philip H. Fielding, New York, N. Y. App. filed June 27, 1903. A receptacle adapted for application to the surface of a tubular wiring conduit, it having a projection carrying the binding screws which enters an orifice made through the wall of the conduit, enabling the wires therein to be attached without cutting and without exposed contacts.

752,839. SYSTEM OF ELECTRIC TRAIN LIGHTING; David C. Henry, Denver, Col. App. filed Sept. 23, 1901. A distribution system comprising a generator, a regulator consisting of two differentially-acting motors, a gear system and a variable resistance operated by the gear system and an automatic switch for including the motors in, or excluding them from, the circuit at predetermined voltages.

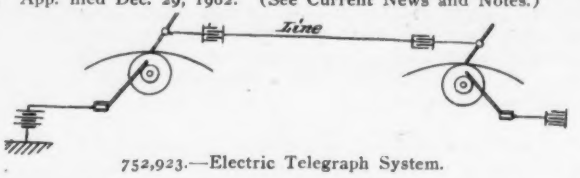
752,840. FLEXIBLE CONDUCTING-CORD; Howard B. Holmes, Evanston, Ill. App. filed Jan. 27, 1902. (See page 476.)

752,843. SIGNALING APPARATUS; Robert B. Kernohan, Pittsburg, Pa. App. filed May 23, 1903. A steam whistle is blown when the circuit is closed through a solenoid magnet.

752,844. MEANS FOR PROVIDING ZINC IN RADIATORS; William Raymond Kinnear, New York, N. Y. App. filed Sept. 8, 1903. (See page 476.)

752,865. ELECTRIC ARC LAMP; Carl Schuster and Christian N. Bergmann. Pittsburg, Pa. App. filed March 20, 1902. Details.

752,894. SELECTIVE SIGNALING; Reginald A. Fessenden, Fort Monroe Va. App. filed Dec. 29, 1902. (See Current News and Notes.)



752,923.—Electric Telegraph System.

752,895. SIGNALING BY ELECTROMAGNETIC WAVES; Reginald A. Fessenden, Pittsburg, Pa. App. filed March 14, 1903. (See Current News and Notes.)

752,909. TELEPHONE SIGNALING MECHANISM; Oscar Olsen Lee, Chicago, Ill. App. filed Jan. 11, 1900. (See page 476.)

752,921. AUDIPHONE-RECEIVER; Hermann G. Pape, Brooklyn, N. Y. App. filed Sept. 13, 1902. (See page 476.)

752,923. ELECTRIC TELEGRAPH SYSTEM; Charles Adams-Randall, New York, N. Y. App. filed Sept. 6, 1902. A single circuit line including transmitters and receivers and a source of energy, the circuit being open or mechanically ungrounded at one end and grounded at the other end.

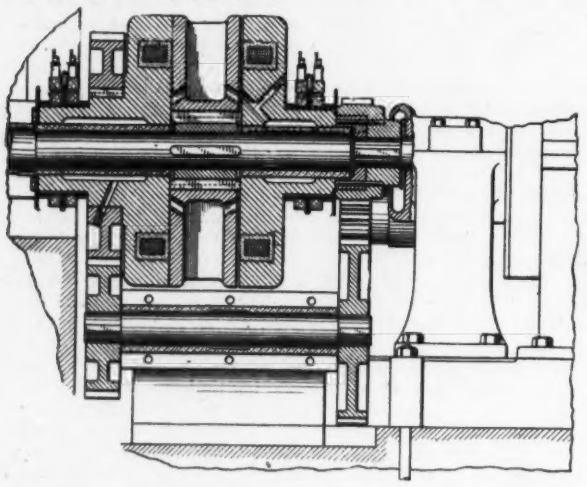
752,942. END-CELL SWITCH; John W. Achard, Philadelphia, Pa. App. filed May 17, 1902.

753,027. OSCILLATING ELECTRIC FAN; Jacob Amrom, New York, N. Y. App. filed June 27, 1903. The fan-carrying arms are oscillated in one direction by an electro-magnet and in the other by a spring, the invention consisting of the details of construction.

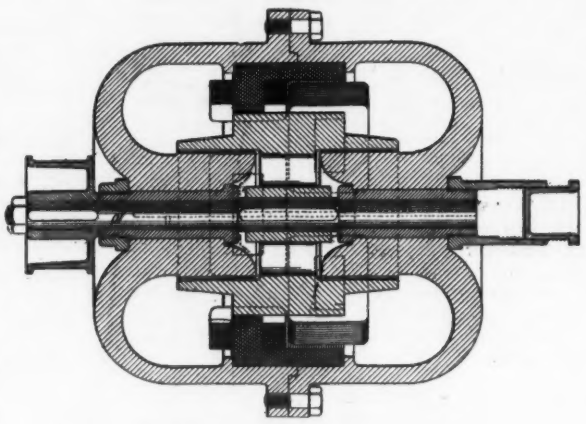
753,035. COMBINED PERCUSSION AND ELECTRIC PRIMER; Thomas G. Bennett and William Mason, New Haven, Conn. App. filed Nov. 23, 1903. The object is to produce a strong, reliable and sensitive primer constructed with particular reference to preventing the rearward escape of gas through leakage or piercing.

753,062. MICROPHONE; Pierre Germain, Fontenay Aux Roses, France. App. filed Oct. 7, 1899. (See page 476.)

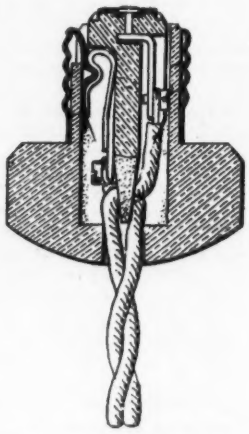
753,067. TELEPHONE OR TELEGRAPH SYSTEM; Robert Hamilton, Milton, Mass. App. filed Feb. 10, 1903. (See page 476.)



752,589.—Electromagnetic Reversing Device.



752,692.—Polyphase Magneto Alternator.



752,833.—Attachment Plug.

752,761. MULTIPLE-SWITCHBOARD SYSTEM; William M. Davis, Chicago, Ill. App. filed Dec. 7, 1900. (See page 476.)

752,812. ELECTRIC BLOCK SYSTEM; Charles W. S. Turner, Mountville, Va. App. filed April 3, 1903. Details of a system in which cars on the same block are able to communicate with each other.

752,820. DYNAMO-BRUSH; Max Bunnig, Gardelegen, Germany. App. filed Oct. 5, 1903. (See page 476.)

752,822. ALARM SIGNAL FOR RAILWAY TRAINS; Hugh E. Butler and Joab L. McCollum, Atlanta, Ga. App. filed Nov. 12, 1903. A cord extending through a train and connected with an alarm apparatus on the last car of the train which is set into operation by the breaking of the cord when the train separates.

752,824. ELECTRIC RAILWAY SWITCH; Harry H. Chandler, Waltham, Mass. App. filed Oct. 24, 1903. Details of a magnet for throwing a switch tongue.

752,833. ATTACHMENT PLUG; Philip H. Fielding, New York, N. Y. App. filed June 27, 1903. The connections with the flexible cord are made on a plug which passes into a central chamber in the attachment plug itself, thereby covering all of the contact screws but affording ready access thereto.

753,136. ALARM SYSTEM; John W. Hasburg, Chicago, Ill. App. filed July 23, 1903. Details.

753,138. PORTABLE ELECTRIC LAMP; Harry C. Hubbell, Brooklyn, N. Y. App. filed July 2, 1903.

753,157. RAILWAY BLOCK SYSTEM; Joseph Morton, New Westminster, Canada. App. filed Oct. 19, 1903. A signal man throws a projection at the track side into position to be struck by a corresponding projection on the train, to thereby operate an alarm on the train.

753,183. TELEPHONE SELECTING DEVICE; Willam D. Watkins, San Jose, Cal. App. filed Aug. 29, 1902. (See page 476.)

753,191. ELECTRIC METER; Thomas Duncan, Chicago, Ill. App. filed July 11, 1901. (See Current News and Notes.)

753,192. ELECTRIC METER; Thomas Duncan, Chicago, Ill. App. filed July 18, 1901. (See Current News and Notes.)

753,193. ELECTRIC METER; Thomas Duncan, Lafayette, Ind. App. filed Oct. 23, 1903. (See Current News and Notes.)

753,194. ELECTRIC METER; Thomas Duncan, Lafayette, Ind. App. filed Jan. 2, 1904. (See Current News and Notes.)

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(*Continued on Page 123.*)

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1	750 Wood, 37½-K.W., comp, iron clad, armt., single phase, with exciter	525
1	900 West., 45-K.W., comp., toothed armt., 2 phase, 1100 v., with exciter	720
1	1200 West., 60-K.W., toothed armt., single ph., comp., with exciter	720
1	1500 Warren-Medberry, 75-K.W., 2 ph., ind. type, with exciter, 2200 v.	600
1	1500 Stan., inductor, 75-K.W., 2 phase, 1100 or 2200 v., with exciter	900
1	1500 West., 75-K.W., comp., distributed winding, 2 ph., 1100 v., with exciter	900
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1	1500 Wood, 75-K.W., comp.	1050
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1	1800 West., 90-K.W., comp., toothed armt.	1500
1	2400 Gen. Elec., 120-K.W., type A 120, latest type, comp., toothed armt	1070
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1	25 Triumph, M. P., comp.	1400
1	35 Crocker-Wheeler	1200
3	40 Gen. Elec., type I B	1900
1	45 Excelsior, M. P.	900
3	45 West., M. P., comp.	1800
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1	50 C. & C., comp., self-oiler	1550
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1	210 Triumph, M.P., comp.	1100
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1	210 Sprague-Lundell, M. P.,	1050
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1	1300 Card, M. P., comp.	500
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1	12 Card, M. P., comp.	800
1	12 Westinghouse, M. P.	1400
1	15 Edison, self-oiler	1400
1	20 Western Electric	150
1	20 Edison, self-oiler, comp.	1400
1	20 Wagner, multipolar	1200
1	20 Keystone, M. P., comp.	950
1	20 Eddy, M. P., comp.	950
1	20 Diehl, M. P., comp.	925
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1	25 Commercial, s-o, comp.	1380
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1	30 Triumph, M. P., comp.	950
1	37½ Keystone, M. P., comp.	800
1	40 C. & C., M. P., comp.	750
1	40 Crocker-Wheeler,	950
1	40 Eddy, M. P., comp.	850
1	40 Keystone, M. P., comp.	900
1	45 Am. Engine C., M. P.	750
2	45 Edison, comp., self-oiler	1000
1	45 Gen. Elec., M. P., comp.	925
1	59 Eddy, M. P., comp.	850
1	50 Triumph, M. P., comp.	900
1	55 Fuller multipolar, comp.	750
1	70 Western Electric, comp.	585
1	75 C. & C., M. P., comp.	525
1	80 C. & C., comp., self-oiler	625
1	100 Edison, comp., self-oiler	650
1	100 Commercial, M. P., comp.	750
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1	125 Siemens & Halske, M. P.	
2	150 National, M. P., comp.	350
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2—100-K.W. General Electric, 4 pole.
2—100-K.W. Edison bipolar.
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1—35-K.W. Loomis, 6 pole.
1—35-K.W. Mather, 4 pole.
1—21-K.W. Riker, 4 pole.
1—17½-K.W. General Electric, 4 pole.
1—15-K.W. Edison bipolar.
1—12½-K.W. Card, 4 pole.
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7½-K.W. Northern, 125 volt, D. C. Hill Vertical Engine (new).
6-K.W. ditto.
4-K.W. ditto.
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65-K.W. Stanley, 60 cy., 2 ph.
20-H.P. Westinghouse, 2 ph., 60 cy.
3-H.P. Westinghouse, 2 ph., 60 cy.
2-H.P. G. E., 3 ph., 60 cycle.

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120-K.W. G. E., s. ph., 1,100 v.
120-K.W. Westinghouse, 2,200 v.
100-K.W. G. E., s. ph., monocyclic.
2—A-70 T. H., s. ph., 1,100 v.
1—60-K.W G. E., s. ph., 1,100 v.
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15-K.W. Eddy, M. P.
10-K.W. Eddy, M. P.
5-K.W. C. & C.
3-K.W. C. & C.
2-K.W. Lundell.
1-K.W. C. & C.

500 VOLTS DIRECT CURRENT
Dynamos or Motors

15-H.P. General Elec., M. P.
7½-H.P. General Elec., M. P.
5-H.P. Sprague.
2-H.P. General Elec.

220 VOLTS DIRECT DURRENT
Dynamos or Motors

40-H.P. Sprague, M. P.
25-H.P. Crocker-Wheeler, M. P.
20-H.P. Card.
15-H.P. Sprague, M. P.
10-H.P. General Elec.
10-H.P. Holtzer Cabot.
7½-H.P. Card.
7½-H.P. Edison.
7½-H.P. C. & C.
5-H.P. Paragon, M. P.
5-H.P. Holtzer Cabot.
5-H.P. Crocker-Wheeler.
3-H.P. Diehl.
3-H.P. C. & C.
2-H.P. General Elec.
2-H.P. Diehl.
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10-H.P. Type C Westinghouse.
7½-H.P. Type C Westinghouse.
5-H.P. Type C Westinghouse.
2-H.P. General Elec.
1-H.P. Westinghouse.
½-H.P. General Elec., 220 or 110 v.
¼-H.P. General Elec.

2 Phase, 440 Volts, 60 Cycles

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15-H.P. Westinghouse.
10-H.P. Westinghouse.
7½-H.P. Westinghouse.
5-H.P. Westinghouse.
3-H.P. Westinghouse.
1-H.P. Westinghouse.

3 Phase, 60 Cycles

5-H.P. Westinghouse, 220 volts.
2-H.P. Gen. Elec., 110 volts.
2-H.P. Westinghouse, 220 volts.
½-H.P. General Elec., 220 volts.
½-H.P. General Elec., 110 volts.

1 Phase, 60 Cycles

7-H.P. Wagner, latest type.
½-H.P. General Elec.
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1 Phase, 125 Cycles

3-H.P. Wagner, latest type.
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2	75	Bullock, multipolar	900
2	75	Gen. Elec. M. P., 4, comp.	700
1	100	Edison, comp.	650
1	100	Siemens & Halske, M. P.	600
3	100	Gen. Elec., M. P., 4, comp.	650
1	100	Westinghouse, M. P., 6	650
1	120	Westinghouse, M. P.	625
1	200	Gen. Elec., M. P., 4, comp., s-o., three bearings	400
1	200	Thompson-Ryan, M. P.	525

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	Lt.	C.P.		Speed.
1	35	2000	T.-H., L D 2 ball	820
1	45	1200	Brush, No. 7.	1050
1	50	1200	T.-H., L D 12, new ball	820
2	50	2000	T.-H., M D 2, s-o., ring	820
1	65	2000	Brush, No. 8	950
1	75	1200	T.-H., M D 12, s-o,	820
1	75	1200	Wood	950
1	100	2000	Wood	600
1	125	1200	Brush, 6.6 amp.	700
2	125	2000	Brush, 9.6 amp.	500
1	125	1200	Excelsior	700

220 TO 250 VOLT MOTORS.

DIRECT CURRENT.

	H.P.		Speed.
1	1	Crocker-Wheeler, self-oiler	900
1	1	Commercial, self-oiler	1200
1	1	Paragon, self-oiler	1100
1	2	Edison, self-oiler	1600
1	2½	Gibbs, multipolar	1250
1	3	Gibbs, M. P.	1400
1	3	Westinghouse, M. P.	1700
1	3½	Paragon, self-oiler	1000
1	5	Western Electric, M. P.	950
3	5	Gibbs, M. P.	1400
1	7½	Western Electric, M. P.	975
1	7½	Towle, M. P.	1050
1	7½	Commercial, M. P.	1300
1	7½	Gen. Elec., M.P., form H	800
1	10	Sprague-Lundell, M. P.	1175
1	10	Keystone, M. P.	1175
1	10	Lundell, M. P.	1060
1	15	Crocker-Wheeler, M. P.	810
1	15	Card, M. P.	700
1	15	Westinghouse, M. P.	1200
1	18	Edison, 15-K.W.	1150
1	25	Western Electric	525
1	25	Keystone, M. P.	725
1	25	Eddy, M. P.	725
1	25	Diehl, M. P.	750
1	30	Crescent, M. P.	800
1	40	Western Electric, M. P.	400
1	40	Keystone, M. P.	700
1	40	Triumph, M. P.	750
1	45	Crocker-Wheeler, M. P.	850
1	50	C. & C., M. P.	560
1	50	Eddy, M. P.	675
1	50	Keystone, M. P.	750

BARGAINS IN
(second-hand) ELECTRICAL MACHINERY

We do not offer old, worn out machines fit for the Junk pile, but the LATEST TYPES of the leading manufacturers.

GREGORY ELECTRIC CO.
54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed.

	H.P.		Speed.
2	60	Edison, self-oiler	75
1	60	General Electric, M. P.	700
1	65	Triumph, M. P.	700
1	65	Eddy, M. P.	650
1	70	Fuller, multipolar	600
1	75	Sprague, self-oiler	500
1	85	Western Electric	500
1	100	C. & C., M.P., 6 pole	450
1	100	C. & C., self-oiler	450
1	125	Edison, self-oiler	550
1	135	Commercial, M. P.	675
2	150	Eddy, M. P.	600
2	200	National, M. P.	300

500 TO 550 VOLT MOTORS.

	H.P.		Speed.
1	1	Crocker-Wheeler	1200
1	1	Diehl, self-oiler	1875
1	1	New England	1100
2	1½	Crocker-Wheeler	1550
2	2	C. & C., self-oilers	1350
1	2	New England, self-oiler	1200
1	2	Crocker-Wheeler	1100
1	2	Lundell	940
2	3	Gen. Elec., type C E	1800
2	3	Crocker-Wheeler	1100
1	3½	Roth, self-oiler, M. P.	950
1	4	Triumph, M. P.	1250
1	4	Perrett, multipolar	725
1	5	Northern, M. P.	1180
1	5	Amer. Engine Co., M. P.	1550
1	5	Westinghouse, M. P.	1500
3	5	Crocker-Wheeler	950
1	7½	Northern, M. P.	1500
1	7½	Crocker-Wheeler	1500
1	7½	General Electric, M. P.	1600
1	10	Perrett, M. P.	600
1	10	Northern, M. P.	1350
1	10	Triumph, M. P.	1100
1	10	Crocker-Wheeler	1275
1	10	General Electric, M. P.	1400

	H.P.		Speed.
1	15	Kester, M. P.	1250
1	15	C. & C., self-oiler	975
1	15	Perrett, M. P.	1100
1	18	T.-H., D 15, self-oiler	1550
1	20	Kester	1400
1	20	S. & H., M. P., Churchward	900
1	20	Perrett, M. P.	700
1	20	Commercial, M. P.	900
1	25	New England, multipolar	900
1	25	Card, multipola	500
1	35	Card, M. P., self-oiler	775
1	40	Wood, multipolar	750

ALTERNATING CURRENT MOTORS.

SINGLE PHASE. 125-133 CYCLES.

	H.P.		Speed.
1	⅓	Wagner, 104 v., aut.	2000
1	1	Fort Wayne, 104 volts	2500
1	1	Wagner, 208 volts, aut.	2000
2	1½	Wagner, 208 volts, aut.	2000
1	5	Wagner, 104 volts, aut.	2000
1	⅓	Phillips, 104 volts	1800
1	⅓	Holtzer-Cabot, 104 volts	2500
1	½	Emerson, 104 volts	2000
1	½	Stanley, 104 volts	2000
1	½	Wagner, 104 volts, aut.	2000
1	1	Fort Wayne, 104 volts	2500
1	1	Wagner, 208 volts, aut.	2000
1	1½	Wagner, 208 volts, aut.	2000
1	5	Wagner, 104 volts, aut.	2000

SINGLE PHASE. 60 CYCLES.

	H.P.		Speed.
2	⅓	Phillips, 104 volts	1800
1	⅓	Phillips, 208 volts	1800
3	½	Phillips, 104 volts	1800
3	½	Phillips, 208 volts	1800
1	1	Phillips, 208 volts	1600
1	1	Phillips, 104 volts	1600
3	1	Wagner, 208 volts	1800

	H.P.		Speed.
1	3	Wagner, 208 volts	1800
1	7½	Wagner, 104 volts	1800
1	15	Wagner, 104 volts, aut.	1200
2	30	Wagner, 104 volts, aut.	1200

THREE PHASE. 125-133 CYCLES.

	H.P.		Speed.
1	3	General Electric, 110 volts	1875

TWO PHASE. 60 CYCLE.

	H.P.		Speed.
1	1	West., type C, 110 v.	1800
1	1	West., type C, 200 v.	1700
1	2	Gen. Elec., 220 v.	1800
1	3	Stanley, 500 v., with condenser	1860
1	7½	West., type B, 400 v.	1200
1	20	West., type C, 208 v.	1130
4	50	West., 400 v., type B.	900
1	75	West., 400 v., type B	900
2	100	West., 400 v., type B	720

THREE PHASE. 60 CYCLE.

	H.P.		Speed.
2	1	Gen. Elec., 110 v.	1800
1	2	Gen. Elec., 220 v.	1800
1	3	Gen. Elec., 104 v.	1875
1	5	Gen. Elec., 110 v., type T I	1200
1	10	Gen. Elec., 110 v., form L	900
1	15	Gen. Elec., 110 v., form L	

ATTENTION, MANUFACTURERS.

Extra Slow Speed Motors, 220 volts, direct-current, suitable for operating drills, lathes, presses and tools of all descriptions electrically—these machines are all in stock and for sale cheap.

	H.P.		Speed.
1	½	Maine, M. P.	450
1	¾	Maine, M. P.	400
4	¾	Maine, M. P.	260
1	1	Maine, M. P.	500
1	1	Maine, M. P.	450
1	1½	Maine, M. P.	500
4	2	Maine, M. P.	260
1	3	Storey, variable speed	300-1500
1	3	Keystone, compound	650
1	3½	Eddy, M. P.	400
1	4	Commercial, M. P.	450
5	5	Western Electric, M. P.	950
1	5	Eddy, M. P.	300
3	5	Belknap, M. P.	230
1	6½	Jenney, M.P., back geared, speed of shaft	440
1	7½	Milwaukee, M. P., series, crane type, grease cup	600
1	8	Crocker-Wheeler, series, crane type	900
1	8	Maine, M. P.	200
1	10	Bernard, M. P.	170
3	10	Bernard, M. P.	130

All machines fully guaranteed.

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Full Line American, Wood, T.-H. Brush

FOR BARGAINS OF THE DISTINCTLY BETTER QUALITY

Direct Connected Sets

1—25-K.W. G. E. 110-v. to McI. & S. Engine.
1—40-K.W. Wood 220-v. to Atlas Engine.
2—40-K.W. Schuckert 110-v. Vert. Comp.
1—50-K.W G. E. 110-v. to Ideal.
1—75-K.W. G. E. 110-v. to Ideal.
1—75-K.W. Am. Ball 220-v. to Am. Ball.
1—10-K.W. Eddy 110-v. to Racine Vert.
1—35-K.W. Am. Ball 220-v. to Am. Ball.
2—125-K.W. Siemens-Halske 125-v. to Am. Ball.
1—1650-K.W. Walker 660-v. to Allis Cross Comp.
1—375-K.W. West 550-v. to West Vert. Comp.
2—225-K.W. West 550-v. to West Vert. Comp.

Engines

2—16x16 Ball & Wood.
1—16x27x16 West Comp.
1—9x12 A. & S.
1—9½x10 Erie Ball.

Transformers

50—Asst. 12 to 50 Lt. Ft. Wayne Wood, new, 40c per light.
6—G. E. Type H 12 to 20 light, 40c per light.

500 Volt Motors

1—½-H.P. Holtzer-Cabot.
1—5-H.P. Fairbanks-M.
2—15-H.P. Fairbanks-M.
3—25-H.P. Fairbanks-M.
1—2½-H.P. Wood.
1—10-H.P. Wood.
1—15-H.P. United States.
1—15-H.P. Rochester.

Miscellaneous

1—Otis 4-cylinder Elevator Pump with D. C. 220-volt Motor.
1—175 H.P. Belt Driven Blake Condenser.

220 Volt Motors

3—3-H.P. Storey.
1—5-H.P. Storey.
1—7½-H.P. Storey.
1—10-H.P. Storey.
1—7½-H.P. Wood.
1—10-H.P. Wood.
1—7½-H.P. Mather.
1—10-H.P. Perret.
1—15-H.P. Perret.
1—15-H.P. Diehl.
1—50-H.P General Electric.

Alternating Current

2—150-K.W. 60-cycle 2200-volt D. C. to Ideal Comp. Engines.
2—A120-K.W. T. H. G. E.
1—45-K.W. 125-cycle West. Price $175.
1—2-H.P. 2-phase 60-cycle G. E.
1—2-H.P. 3-phase 60-cycle G. E.
1—50-H.P. 3-phase 25-cycle West.
2—30-H.P. 3-phase 25-cycle West.
2—20-H.P. 3-phase 25-cycle West.

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Wanted Central Station Managers AND USERS OF MACHINERY TO CORRESPOND WITH US

We have an exceptionally good proposition for those desiring to exchange their equipment for something larger, more improved or more modern.

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THOMPSON-BONNEY CO., 45 YORK STREET, BROOKLYN, N.Y., U.S.A.

For Sale:—Four 22' and 42' x 48'

Hamilton Tandem Compound Condensing Corliss Engines

With Independent Condenser for Each. Wheels: 24 ft. x 50 ins. 60,000 lbs. Capacity: 750 to 1,000 H. P. Each. Located in New York City.

900-H.P. 34x60 International Power Corliss.
450-H.P. 16 and 30x42 Allis Compound Corliss.
450-H.P. 24x48 Brown Corliss.
400-H.P. 23x60 Geo. H. Corliss.
300-H.P. 20x48 Harris Corliss.
275-H.P. 20x42 Hamilton Corliss Engine.
250-H.P. 18x48 Lane and Bodley Corliss.
225-H.P. 18x42 Hamilton Corliss.
200-H.P. 18x36 Bates Corliss.
200-H.P. 12 and 22x42 Atlas Compound Corliss.
175-H.P. 16x42 Allis Corliss.
150-H.P. 15x38 Brown Corliss.
125-H.P. 14x36 Putnam Corliss.
100-H.P. 12x36 Harris Corliss.
85-H.P. 12x30 Lane and Bodley Corliss.
650-H.P. 28½x52 Buckeye Automatic.
450-H.P. 24x48 Buckeye Automatic.
400-H.P. 16½ and 28½x27 Buckeye Compound Automatic.
250-H.P. 16 and 27x16 Westinghouse Compound.
150-H.P. 15x14 Ideal Self Oiling Automatic.
100-H.P. 13x12 Ideal Self Oiling Automatic.
90-H.P. 12x20 Atlas Side Crank Automatic.
90-H.P. 12x16 Erie Center Crank Aut.
40-H.P. 9x13 Frost Side Crank Automatic.

BOILERS

1—350-H.P. Babcock and Wilcox Boiler, 150 lbs.
1—280-H.P. Babcock and Wilcox Boiler, 150 lbs.
2—265-H.P. Babcock and Wilcox Boilers, 150 lbs.
3—265-H.P. Babcock and Wilcox Boilers, 135 lbs.
1—175-H.P. Babcock and Wilcox Boiler, 125 lbs.
1—172-H.P. Babcock and Wilcox Boiler, 130 lbs.
1—250-H.P. Cahall Vertical Boiler, 160 lbs.
1—72x18 Tubular Boiler, 125 lbs.
7—72x18 Tubular Boilers, 100 lbs.
3—72x16 Tubular Boilers, 100 lbs.
8—66x18 Tubular Boilers, 100 lbs.
3—66x16 Tubular Boilers, 100 lbs.
1—60x18 Tubular Boiler, 100 lbs.
4—60x16 Tubular Boilers, 100 lbs.
2—60x14 Tubular Boilers, 120 lbs.
Wainwright Heaters, 50, 75, 100, 150 and 200 H.P.

WHITEHEAD MACHINERY CO., Davenport, Iowa.

FOR SALE.

DIRECT CONNECTED.

30-K.W. Eddy dynamo to Watertown engine, 110 volts.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-Amp. Edison dynamo to Brotherhood engine, 80 volts.
20-H.P. Elektron 220 volt motor to Morse Williams freight elevator.

BELTED.

60-amp. Crocker-Wheeler to Herresoff engine, 110 volts.
2000 volt Electro Dynamic arc dynamo, 10 amperes.
500-Lt. Edison dynamo, 110 volts.
60-amp. Westinghouse dynamo to Westinghouse engine, 110 volts.
35-amp. Sprague dynamo to Hornby Ackroyd oil engine.
600-Lt. Weston dynamo, 110 volts.
500-Lt. Edison Dynamo, 110 volts, D.C. to Brotherhood engine.
400-Lt. Excelsior dynamo, 110 volts.
45-H.P. C. & C. motor, 230 volts.
30-H.P. C. & C. motor, 230 volts.
15-H.P. Thomson-Houston motor, 500 volts, with spare armature.
15 General Electric, 2-H.P., 220 volt motors.
12 Siemens & Halske 5-H.P., 220 volt motors, 220 volts, 1550 R.P.M.
2 search lights.
These motors are dust proof and series wound.
Large stock of smaller dynamos and motors.
Repairing of electrical machinery in all its branches.

JORDAN BROS., 74 Beekman St., N. Y

WANTED

TECHNICAL INVENTORS. Engage a registered expert patent solicitor. I will furnish (in answer to a postal), certificates of honesty and competency from fifty professors, members A. I. E. E., A. Soc. M. E., and other technical clients; impossible for an ordinary solicitor who only knows "general electrical principles" to draft proper technical claims, etc. Address No. 1322, care Electrical World and Engineer, New York.

FOR SALE.

1 Second-Hand 15-H. P. 275 R. P. M. Nash Double-Cylinder Gas Engine, used about 6 months, being replaced by a 95-H.P. Nash. In good operative condition.

DOUBLEDAY HILL ELECTRIC CO.,
219 Liberty Street, Pittsburg, Pa.

FOR SALE

Complete new apparatus embodying all the most recent improvements in machinery employed in the manufacture of incandescent electric lamps. Will guarantee lamp manufacturers results as to cost and quality. Address No. 1158, care Electrical World and Engineer, New York.

Battery Compound

FOR

ALL ZINC-CARBON BATTERIES

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If you do not know who makes what you want to buy, consult the advertising pages of ELECTRICAL WORLD AND ENGINEER.

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100-K.W., 8-pole, General Electric Generator, direct connected to Automatic Engine.
100-K.W., 6-pole, Western Electric, 115 v. Generator, direct connected to 16x16 Ideal.
120-K.W., General Electric, 60-cycle Alternators.
150-K.W., Ft. Wayne Wood Aternator.
75-K.W., Ft. Wayne Wood Alternator.
75-K.W., 6-pole, Western Electric, 220 v.
40-H.P., 4-pole, Western Electric, 220 v.
175-K.W. Edison Bi-polars.
100-K.W. Edison Bi-polars.
200-K.W. General Electric Railway Generator.
500-H.P. Cross compound Cooper Condensing Corliss with Condenser.
20x42 Allis Corliss.
24x20 Ideal Automatic, latest type.

Write for current price list of dynamos, engines and boilers.

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LOUIS HECK, Successor to STUCKY & HECK, ELECTRICAL MANUFACTURING CO., Lit'd.

Electrical and Mechanical Engineers and Draughtsman

Every System—Repairing, Re-winding, Re-construction

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PROPOSALS

CITY OF LAUNCESTON, TASMANIA.

ELECTRICAL PLANT FOR SALE.

The Corporation of the City of Launceston has for sale the following Electrical Plant:

I. ALTERNATING PLANT.

5 Water driven Turbines of 160-H.P. each, by Gilbert Gilkes, of Westmoreland.
5 Alternators of 100-K.W. each, by Siemens Bros. & Co.
Switchboard complete with instruments.
A large number of suitable transformers, meters and single phase motors and other minor plant apparatus.

II. DIRECT CURRENT ARC LIGHTING PLANT (SERIES SYSTEM).

5 Siemens Arc Light Dynamos each for 35 lamps (7.5 amperes).
4-Circuit Switchboard complete with instruments.
About 140 Siemens small band arc lamps.
About 120 lanterns for the above.

Full particulars may be obtained on application to the City Electrical Engineer, Town Hall, Launceston, Tasmania.

C. W. Rocher,
Town Clerk.

Town Hall,
Launceston,
8th December, 1903.

PROPOSALS will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 12 o'clock noon, March 15, 1904, and publicly opened immediately thereafter, to furnish at the navy yard, New York, N. Y., a quantity of electric motors, motor generators, generating sets, keyboards for night signal sets, rubber tape, conduit and fittings, wire, wiring appliances, incandescent lamps, electric light fixtures, rubber sockets, steam tight globes, bolts and nuts, rivets, khaki-dyed duck leggins, table linen, china ware, glassware, silver-plated ware, hardware, ingot copper, pig iron, bar and sheet steel and shapes, Banca tin, magnesia pipe covering, brass pipe, copper pipe, bronze tubing, steel tubes, brass pipe fittings, valves, bath tubs and bathroom supplies, terra cotta, coffee urns, corn pith cellulose, tinned pears, tinned apricots, tinned peaches, vinegar, and various machine tools, comprising bolt cutters, punching press, squaring shear, rip-saw machine, engine lathe, and planers. Blank proposals will be furnished upon application to the navy pay office, New York, N. Y. H. T. B. Harris, Paymaster General U. S. N. 2-19-04

For Sale. DIRECT CONNECTED APPARATUS

Direct Connected Direct Current
125 TO 250 VOLTS

1—425-K.W. unit consisting of two 210-K.W. 140-volt MP engine type General Electric generators, 120 R.P.M., direct connected to one 24 x36 Wright Corliss engine, for use on 125 or 250-volt circuit.

1—160-K.W. unit consisting of two 80-K.W. engine type MP 6 80-230 R.P.M. General Electric generators mounted on one base and direct connected to one 15 and 25x 16 horizontal tandem compound automatic Ball engine, 125 to 250 volts Edison three-wire system.

1—150-K.W. 110-volt MP 6 engine type General Electric generator direct connected to one 14 and 21x36 Penna. Iron Works tandem compound Corliss engine, 102 R.P.M.

2—150-K.W. 125-volt MP 8 150-225 R.P.M. latest type vertical split frame Westinghouse generators direct connected to two 18x16 simple horizontal 4-valve Corliss type steam jacketed cylinder Ball & Wood engines. These outfits are brand new. Immediate delivery.

1—125-K.W. 125-volt MP Siemans-Halske generator direct connected to simple engine.

1—75-K.W. 125-volt MP 6 engine type General Electric generator, 270 R.P.M., direct connected to one 14 x14 Ideal horizontal centre crank, high speed, automatic engine.

1—75-K.W. 125-volt MP 6, latest engine type Westinghouse generator, 275 R.P.M., direct connected to one 13x12 Ball & Wood centre crank, high speed automatic, simple engine.

1—60-K.W. 125-volt MP 6 60-280 R.P.M. engine type General Electric generator, direct connected to 12x12 Armington & Sims horizontal, centre crank, high speed, automatic engine, with new type governor.

1—62½-K.W. 250-volt MP 6 engine type Bullock generator, 275 R.P.M., direct connected to 14x12 Ames horizontal, centre crank, high speed, automatic engine.

1—50-K.W. 125-volt MP engine type G.I. generator, 300 R.P.M., direct connected to one 12x12 horizontal high speed Russell engine, with Rites governor. Brand new.

2—42-K.W. 125-volt engine type Westinghouse MP generators, direct connected to two 12x12 horizontal, high speed Alfree engines.

1—50-K.W. unit consisting of two 25-K.W. MP 6 engine type General Electric, 305 R.P.M., direct connected to one 11x12 simple horizontal, high speed Ball engine, for use on Edison 3-wire 125 or 250-volt circuit.

1—30-K.W. 125-volt engine type Westinghouse generator, 300 R.P.M., direct connected to one 11x10 simple, horizontal, automatic high speed Ball engine.

IMMEDIATE SHIPMENT
IN STOCK Jersey City and St. Louis Factories

1—25-K.W. MP 6 125-volt engine type General Electric generator, 360 R.P.M., direct connected to 8 and 13x8 Westinghouse vertical compound engine.

1—20-K.W. 125-volt MP 4 engine type Triumph generator, 350 R.P.M., direct connected to one 8x10 horizontal, high speed, automatic Chandler & Taylor engine.

1—12½-K.W. 125-volt Sprague Lundell type generator, 280 R.P.M., direct connected to one 20-H.P. two-cylinder National Meter Company's gas engine. This outfit is practically new.

1—10-K.W. 125-volt MP engine type Eddy generator, 400 R.P.M., direct connected to Wm. Bagley & Sons vertical, automatic, high speed engine.

ROSSITER, MacGOVERN & Co.,

FACTORIES Jersey City, N. J. St. Louis, Mo.
MAIN OFFICE: Whitehall Building, 17 Battery Place, New York City.
BRANCH OFFICES: 84 State St., Boston. Missouri Trust Building, St. Louis, Mo.

(*Continued from Page 120.*)

POSITION WANTED.—By technical graduate in laboratory or with engineer; experienced in experimental work and general testing; familiar with the adjustment of instruments of precision; excellent mechanic and draughtsman. Address No. 1338, care Electrical World and Engineer, New York.

POSITION WANTED.—An American father, retired, is willing to pay a bonus for a situation for his 20-year-old son with a large electrical contracting concern; good personality, quick, mechanical. Address No. 1347, care Electrical World and Engineer, New York.

POSITION WANTED.—As manager or superintendent; fourteen years' practical experience installing and operating light and power plants, water power and steam. Address No. 1282, care Electrical World and Engineer, New York.

POSITION WANTED.—City sales manager of large New York supply house for past 3 years is at liberty; would like to represent manufacturer in the market; can furnish best references both as to ability and character. Address No. 1349, care Electrical World and Engineer, New York.

POSITION WANTED.—Experienced man as foreman for central station work within 300 miles of New York City; competent on single, two or three phase installations, repairs or "change overs"; thorough on inside wiring or subway construction; can give good references. Address No. 1348, care Electrical World and Engineer, New York.

HELP WANTED.

The rate for "Help Wanted" advertisements of forty words or less is one dollar and fifty cents an insertion; additional words three cents each, payable in advance. Remittance and copy should reach this office not later than Tuesday morning for the next succeeding issue.

WANTED.—Solicitor with experience in electric lighting; give references. Address No. 1320, care Electrical World and Engineer, New York.

WANTED.—A man with a good all around knowledge of electricity, electrical and machine work; one with experience in spark coil work, and who can handle men preferred; state age, experience and salary wanted. Address No. 1350, care Electrical World and Engineer, New York.

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A set nearly complete. This set lacks only 13 numbers and 3 vols. of a complete set which consists of 53 vols. 22 vols. are bound in half red morocco, others in parts. The missing vols. are 19, 40 and 52. A complete set sells for $100.00. The price of this set is $65.00.

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from the commencement to December, 1903, 17 vols. unbound, in very clean condition, mostly uncut, $35.00.

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A complete set of the *Transactions* and *Proceedings* from the commencement to December, 1896, consisting of the *Transactions*, Vols. 1 to 36, and the *Proceedings*, Vols. 1 to 22 complete, unbound, with two general indexes to the *Transactions*, Vols. 1 to 21 and Vols. 22 to 27. $125.00.

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For offers of other sets see adv. in ELECTRICAL WORLD AND ENGINEER, Oct. 24 and 31.

EDWARD CALDWELL, - 112 Liberty St., New York

POSITION WANTED.—By electrical engineer, college graduate; extensive experience installing and operating electric light and power plants, pole line construction, house wiring, meters, etc.; able mechanic and armature winder; prefer installing or superintendent of lighting plant. Address No. 1288, care Electrical World and Engineer, New York.

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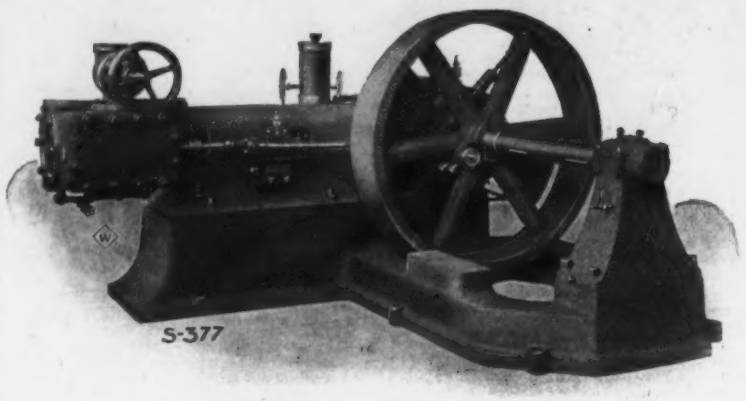

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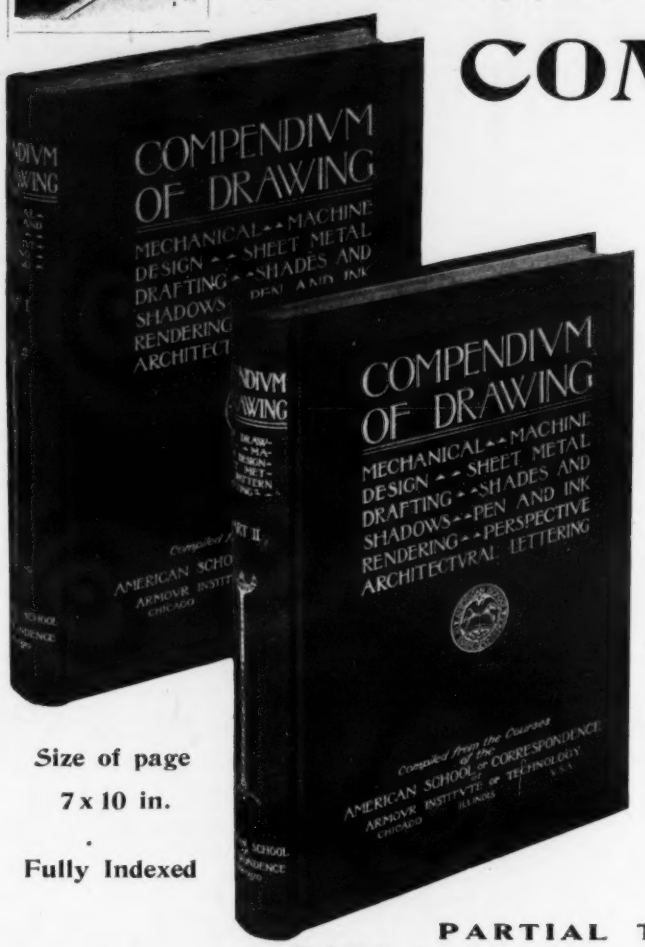

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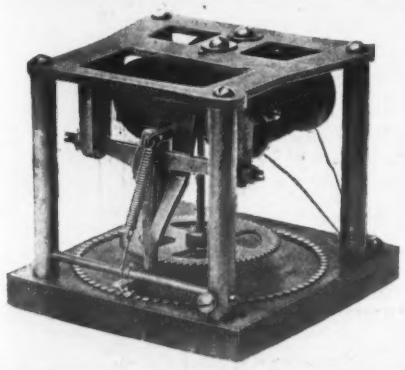

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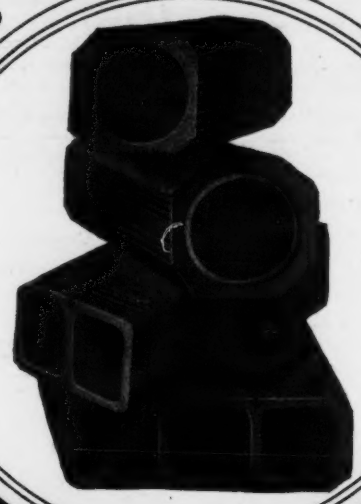

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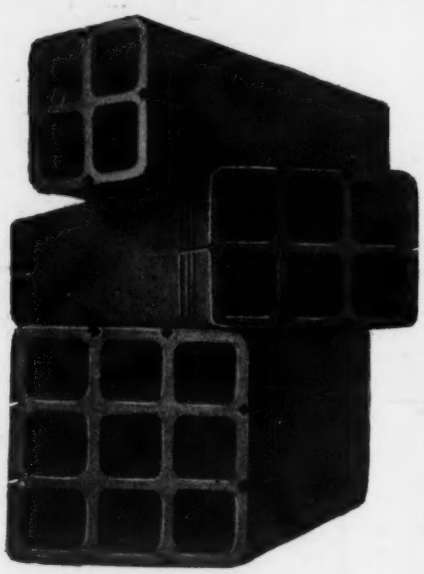

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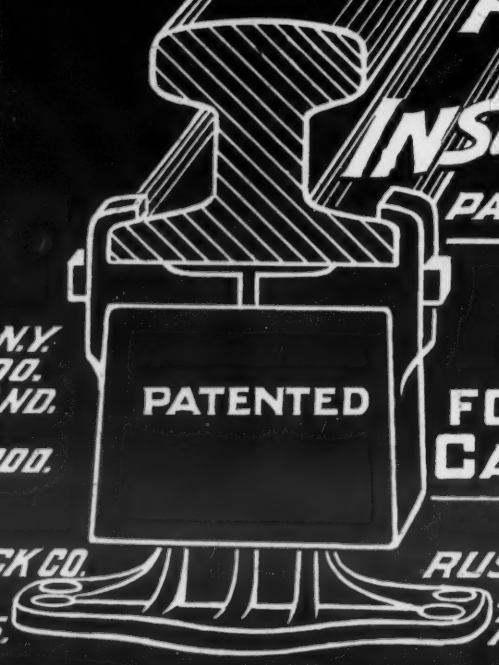

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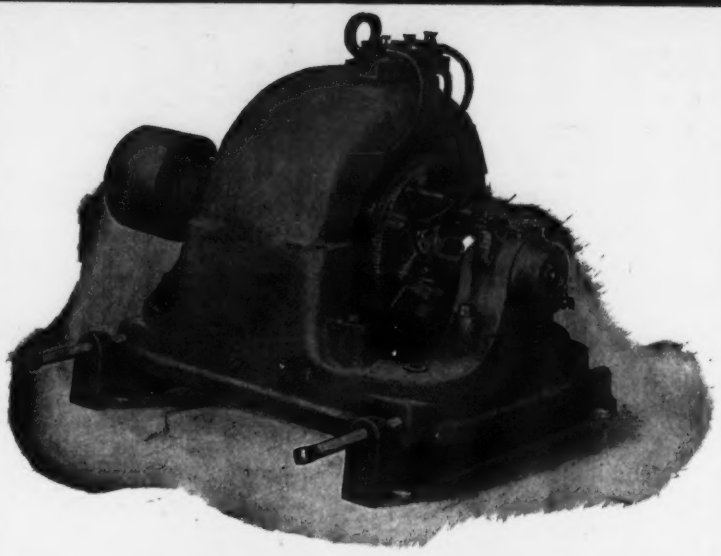

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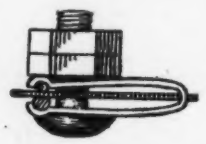

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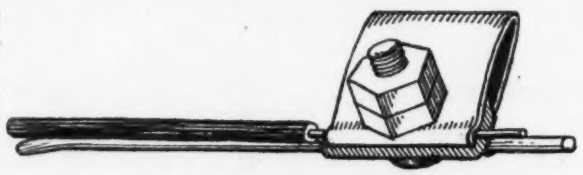

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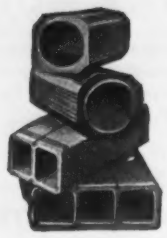

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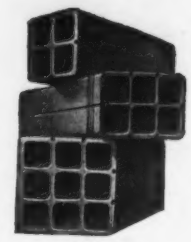

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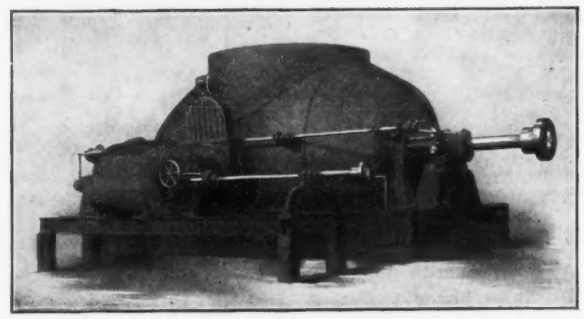

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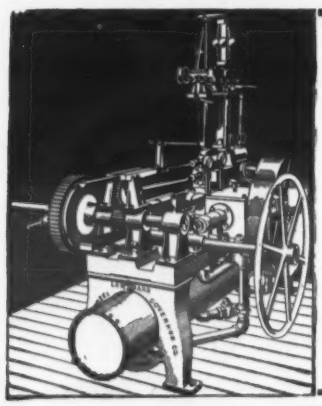

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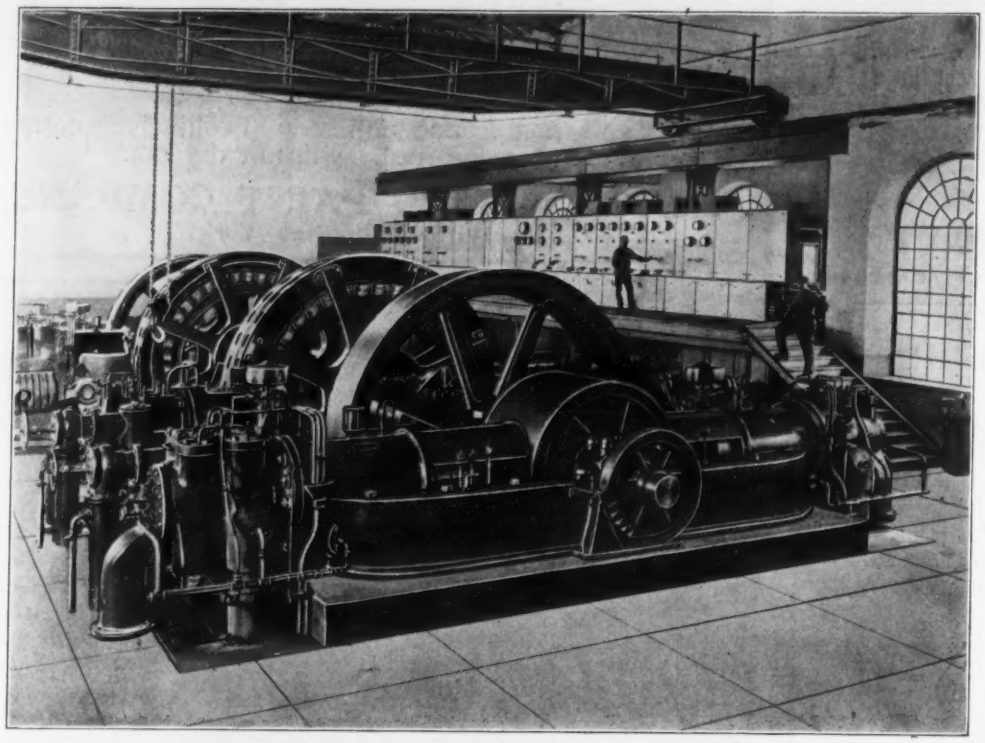

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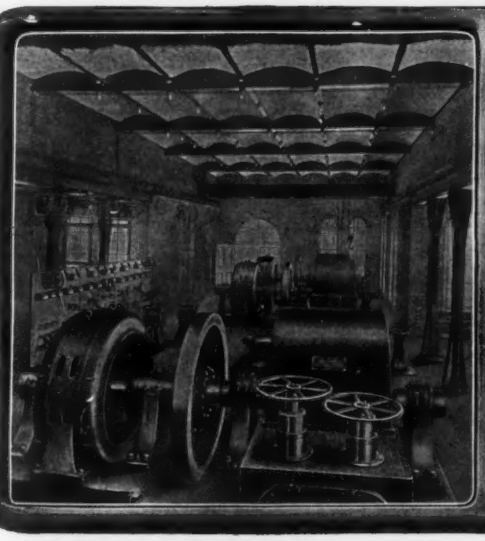

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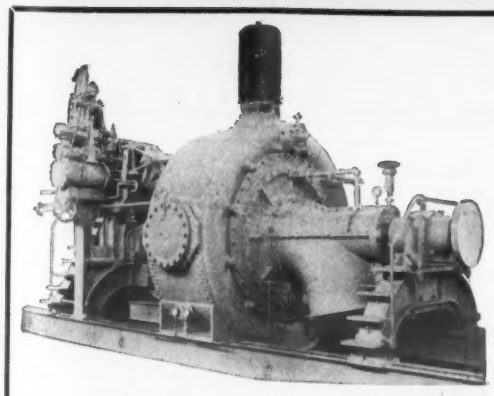

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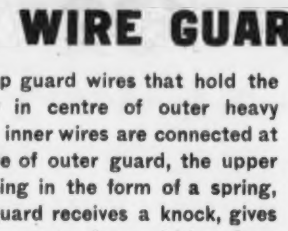

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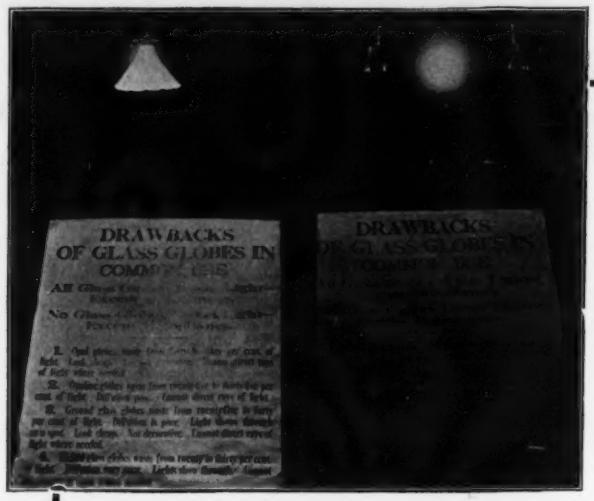
THE STANDARD PAINT COMPANY,
100 William St, New York.



This illustration is from an untouched photograph.

Both sheets are illuminated by 16-c.p. Edison electric lamps. The one on the right is bare; the other has a patent **"Pagoda" prismatic reflector** No. 2631 on it.

ANY LAMP

will give increased illumination if equipped with a patent **"Pagoda"** reflector that applies the laws of optics to the problem of illumination.

We are the *only* manufacturers of scientific optical glass reflectors.

The best proof of customers' satisfaction is a growing business. Our sales for the past years show an increase of over 100 per cent. of the preceding year's business.

The Illuminating Appliance Co.
173 GREENWICH STREET, NEW YORK

CHICAGO INSULATED WIRE CO.
152-154 Lake St. Room 15.
CHICAGO, ILL. U.S.A.
WIRES AND CABLES

The First and Most Important Point

about advertising is to select the right medium. If you want to do business with any man in the electrical field in any part of the world, the right medium to advertise in is

Electrical World and Engineer